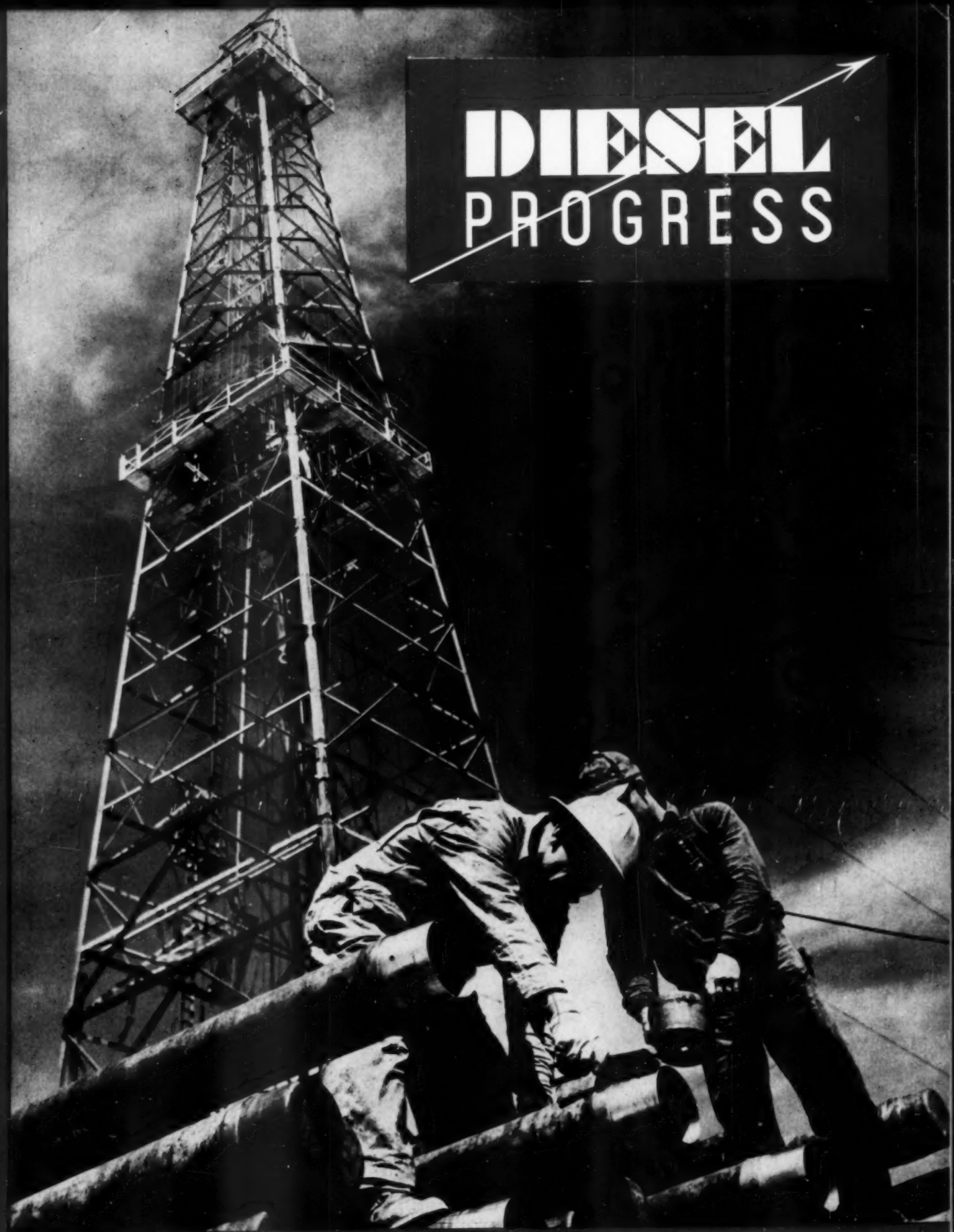
DIESEL PROGRESS

IN INDUSTRY • IN TRANSPORTATION • ON THE SEA • IN THE AIR



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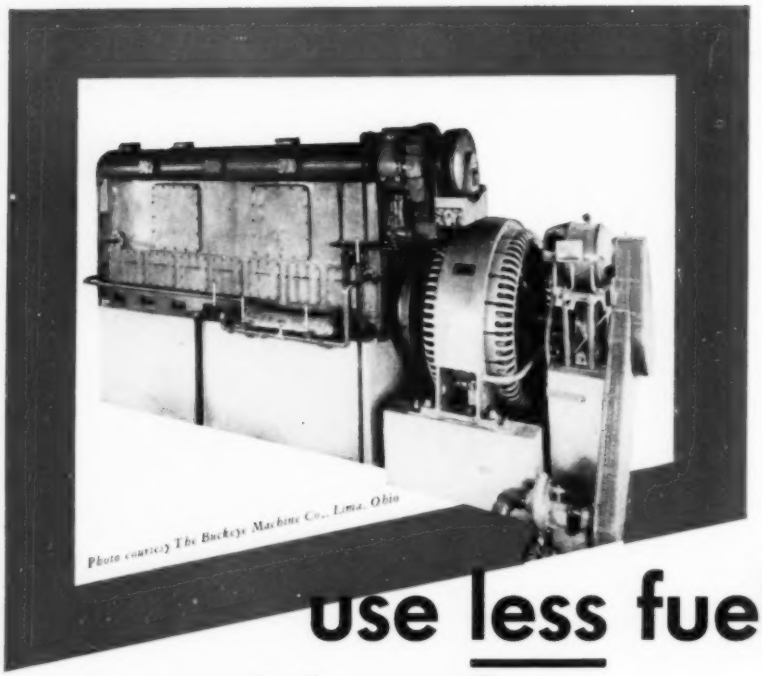

Photo courtesy The Buckeye Machine Co., Lima, Ohio

use less fuel... spend less for maintenance

Keep your Diesel *rings free* by lubricating with Texaco Ursa Oils

YOU PROFIT in two important ways when you lubricate your Diesels with *Texaco Ursa Oils* . . . you 1) use less fuel; 2) spend less on servicing.

Texaco Ursa Oils resist oxidation, stand up under heat and pressure, guard against formation of carbon, gum and sludge. Engines stay clean, valves active, ports open and rings free, assuring better compression and combustion. You get full power from every gallon of fuel . . . longer life from bearings, pistons, rings and cylinder liners.

There is a complete line of *Texaco Ursa Oils.* Leading Diesel manufacturers approve them, and operators everywhere use them. In fact—

More stationary Diesel hp. in the U. S. is lubricated with Texaco Ursa Oils than with any other brand.

Let a Texaco Lubrication Engineer help you secure more efficient and economical Diesel operation. Call the nearest of the more than 2300 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Ursa Oils

FOR ALL DIESEL ENGINES

DIESEL PROGRESS, for September, 1949. Volume XV, Number 9. DIESEL PROGRESS is published monthly by Diesel Engines, Inc., 2 W. Forty-fifth St., New York 19, N. Y. Rex W. Wadman, President. Subscription rates: $5 per year, single copy 50c. Acceptance under 34.64, P. L. & R., at East Stroudsburg, Pa.

Power Plus *again and again*

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COMBINES PRECISION MANEUVERABILITY AND COMPACT POWER . . . . . .

Port Oil Company's "Oil King" of welded steel construction with Duoform bow powered and steered by 40 H. P. Model 0-42

YES, a 40 H. P. Diesel HARBORMASTER adequately handles this self-propelled fuel boat with a full load of 20,000 gallons.

. . . INCREASES OPERATING EFFICIENCY CUTS OPERATING COSTS

The "Oil King" operates in Boston Harbor, refueling the fishing fleet and other craft. On this job—as in river towing, the Northwest's oyster fields, Alaska's salmon industry—anywhere, any time, Harbormaster gives you dependable power, extreme maneuverability, all 'round economy of operation. Models range from 20 to 300 H. P. Write or wire today for complete details. Look to Harbormaster for more profitable operation.

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High Fidelity Marine Engines since 1885

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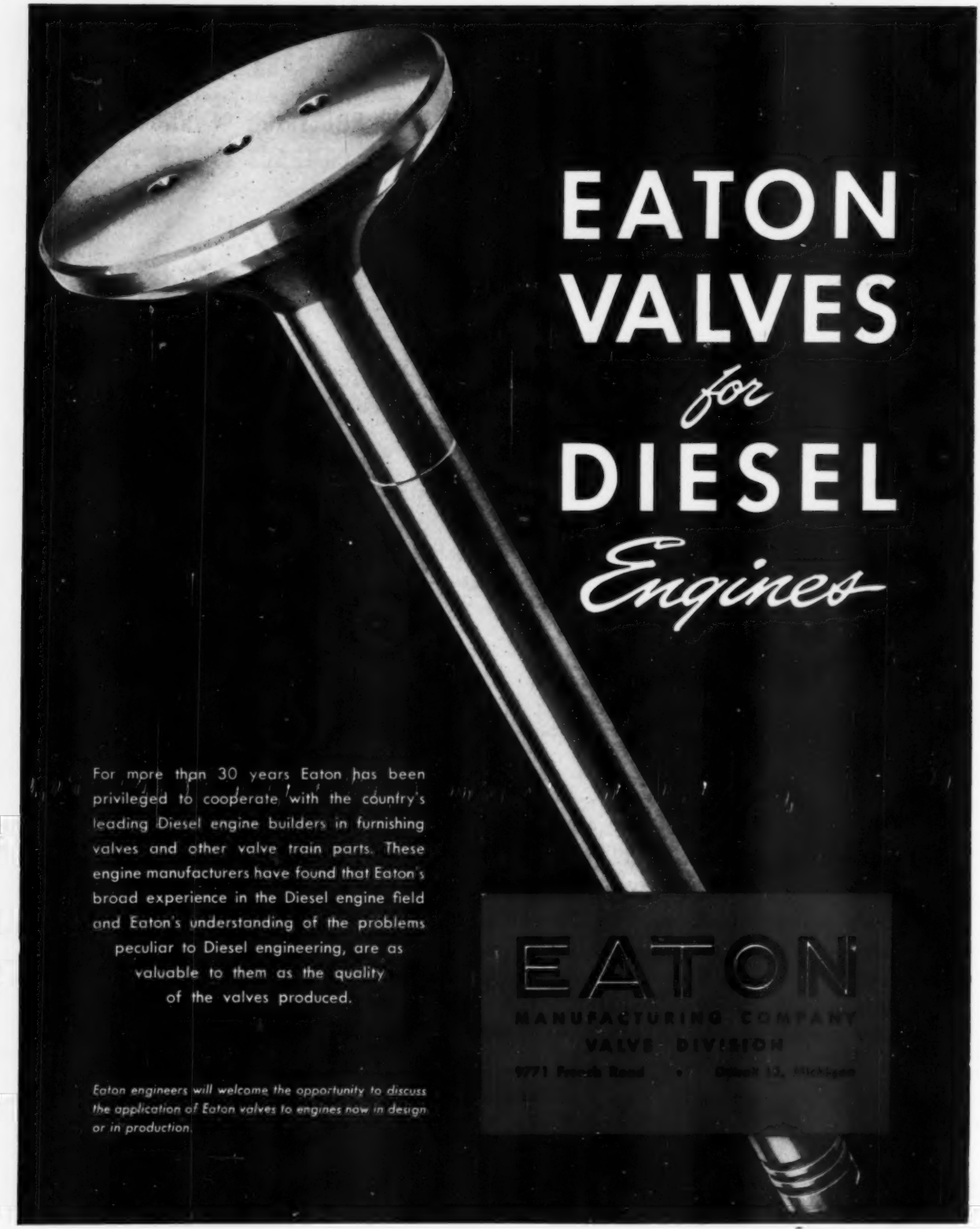
EATON
VALVES
for
DIESEL
Engines
For more than 30 years Eaton has been privileged to cooperate with the country's leading Diesel engine builders in furnishing valves and other valve train parts. These engine manufacturers have found that Eaton's broad experience in the Diesel engine field and Eaton's understanding of the problems peculiar to Diesel engineering, are as valuable to them as the quality of the valves produced.
Eaton engineers will welcome the opportunity to discuss the application of Eaton valves to engines now in design or in production.
EATON
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These Vital Parts fit *ALL* GM "71" DIESELS

Every GM Series 71 Diesel engine, whether a two-cylinder or one of a Quad 6, *has the same bore and stroke.* This means that practically all moving parts are exactly the same for any size Series 71 engine from 43 to 520 continuous B.H.P.

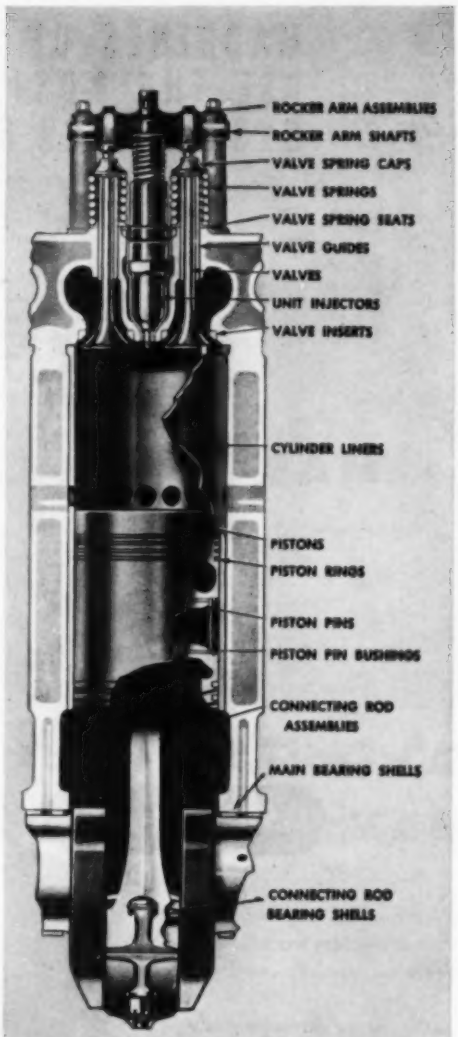
For example, all of the GM Diesel parts shown here, plus dozens more, are completely interchangeable, regardless of the number of cylinders, horsepower, age or usage of the engine.

To large contractors, oil drillers, truck or boat fleet operators, this unique feature of GM Diesel design means lower parts inventories and less time out for maintenance.

To the individual owner, it brings a no less important benefit. A *single* inventory of basic parts on the distributor's shelves increases the availability to owners of the *right* part when it is needed.

Maximum parts interchangeability is just one of the many *plus* values that go with your purchase of General Motors Diesel engines—a good reason why it pays to *standardize* on GM Series 71 Diesels.

For topmost satisfaction and reliability, always buy genuine "Factory-Engineered" GM Diesel parts from your authorized distributor or dealer.



CUTAWAY OF CYLINDER FROM GM SERIES 71 DIESEL

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GM GENERAL MOTORS DIESEL POWER

MACHINES OF GREAT PERFORMANCE USE THE MOST DEPENDABLE OILING SYSTEM EVER DEVELOPED . . .

Foremen and machine operators know something significant that the "Front Office" may overlook, namely that machine performance is in direct relation to the quality of the oiling system.

The six models of Madison-Kipp lubricators meet almost every application requirement. They are used as original standard equipment on America's finest machine tools, work engines and compressors.

The bottom rotary drive four-feed Model SVH Madison-Kipp high pressure lubricator illustrated is for air compressor service.

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. . . *that* CUTS OPERATING COST *and* IMPROVES ENGINE PERFORMANCE

WHEN YOU BUY YOUR NEXT DIESEL

You'll find that most leading makes of Diesels can be obtained today with the Lanova Combustion System. But to be certain of getting all the operating advantages of this improved combustion chamber design, be sure to specify it by name. If you desire the names of the manufacturers who offer it, we would be glad to furnish the complete list on request.

In the fleeting fraction of a second in which raw fuel must be converted into power, the Lanova Combustion System goes into action and produces results that put the Diesel on a new basis of operating smoothness, efficiency and economy.

Its unique principle of controlled rotary turbulence speeds up the mixing of fuel with the air necessary to support complete combustion. It controls combustion pressures by isolating them in the famous Lanova energy cell where they cannot impose life-shortening hammerblows on pistons, bearings and rings—and times the release of these pressures so that they exert a smooth, powerful push on the piston on every working stroke.

Next time you buy Diesel power remember that the split second in which combustion takes place is one of the most important moments in the life of your Diesel. That's why you'll want to safeguard it with the Lanova Combustion System.

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38-19 30th Street Long Island City 1, N. Y.

LANOVA *makes Diesels purr*

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A Sure Sign of Finer Fuel Injection Service!

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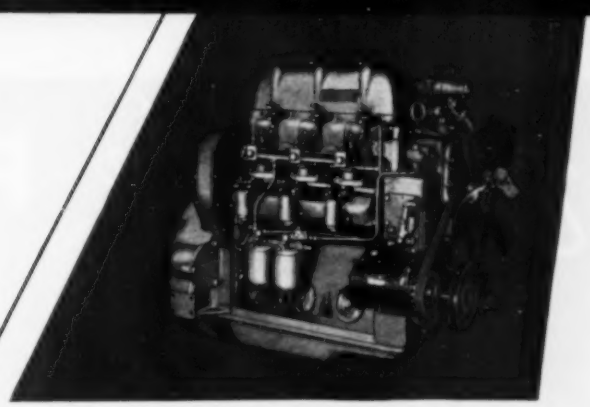
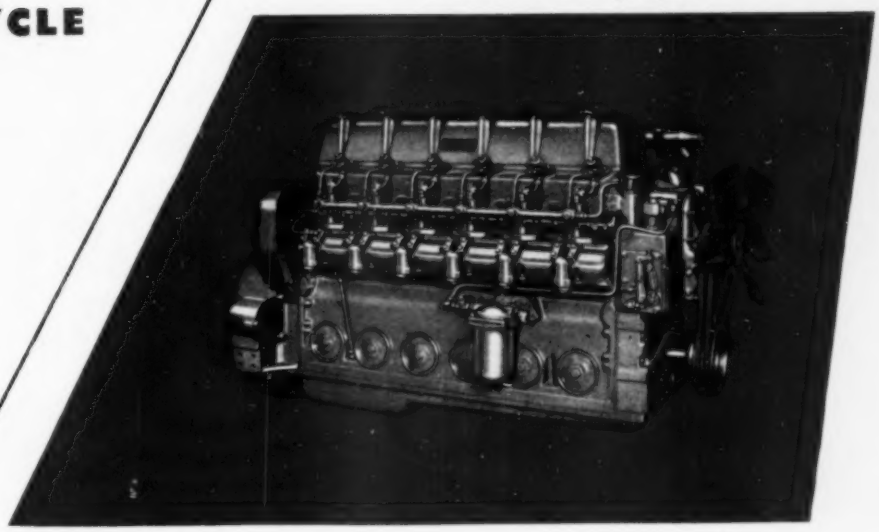


Model 387-C 3 cylinder

P&H DIESELS

2 CYCLE

Model 687-C 6 cylinder



Built for the toughest job known

Now — the new P&H Diesels are ready — after years of intensive research, development and testing in the most grueling of diesel applications — excavator service.

The new P&H Diesels introduce a number of advancements in design — in performance — and in easier servicing — which will be welcomed in many fields of diesel usage, mobile, stationary and marine.

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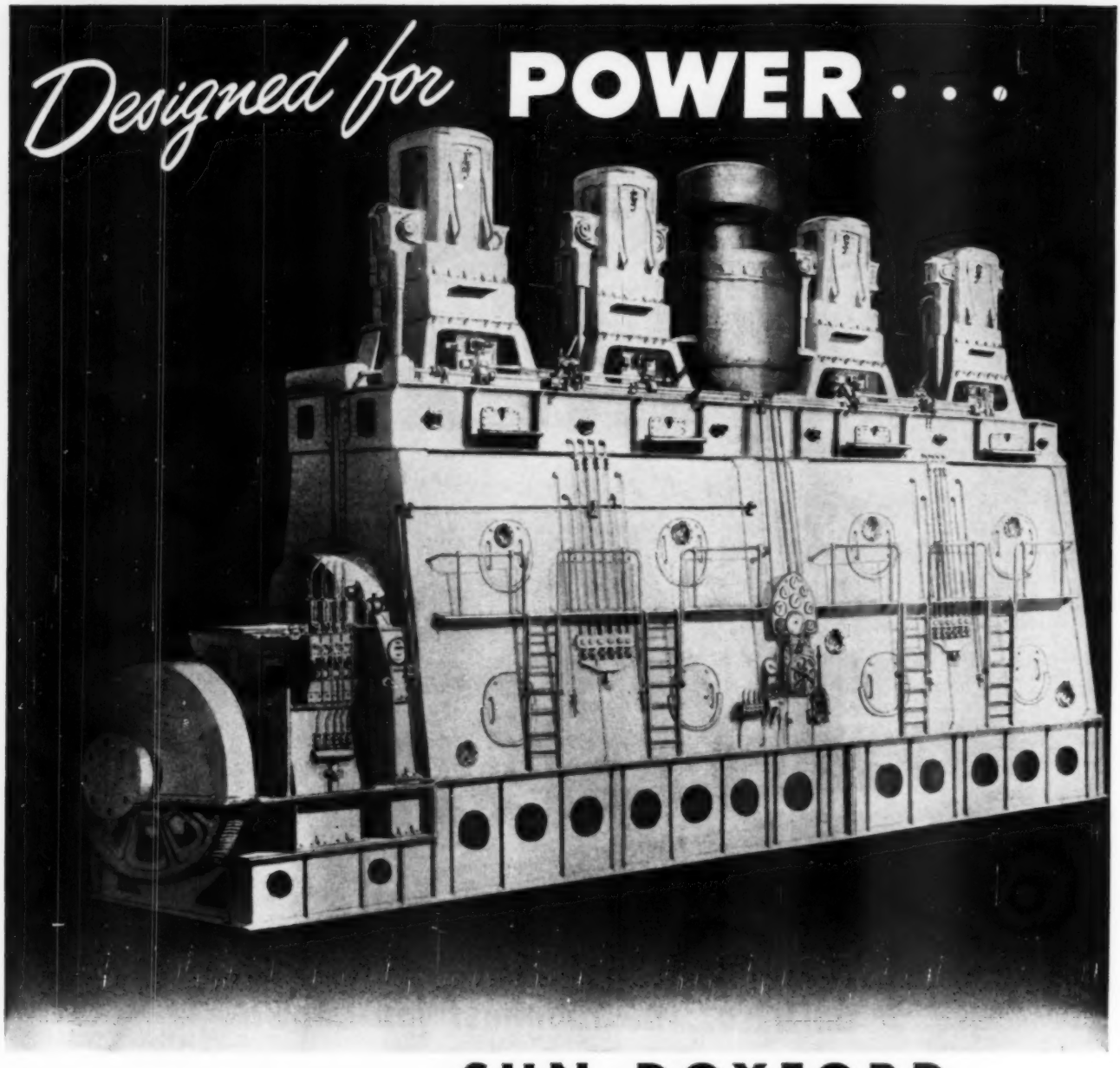

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2 Cycle Opposed-Piston DIESEL ENGINES

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ON THE DELAWARE • CHESTER, PA.

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HARRISON COOLING

Helps Keep 'Em Available!

The majority of the Diesel locomotives built today are equipped with Harrison radiators and oil coolers.

Thus, effective jacket water cooling and the maintenance of oil temperatures within the required range are assured.

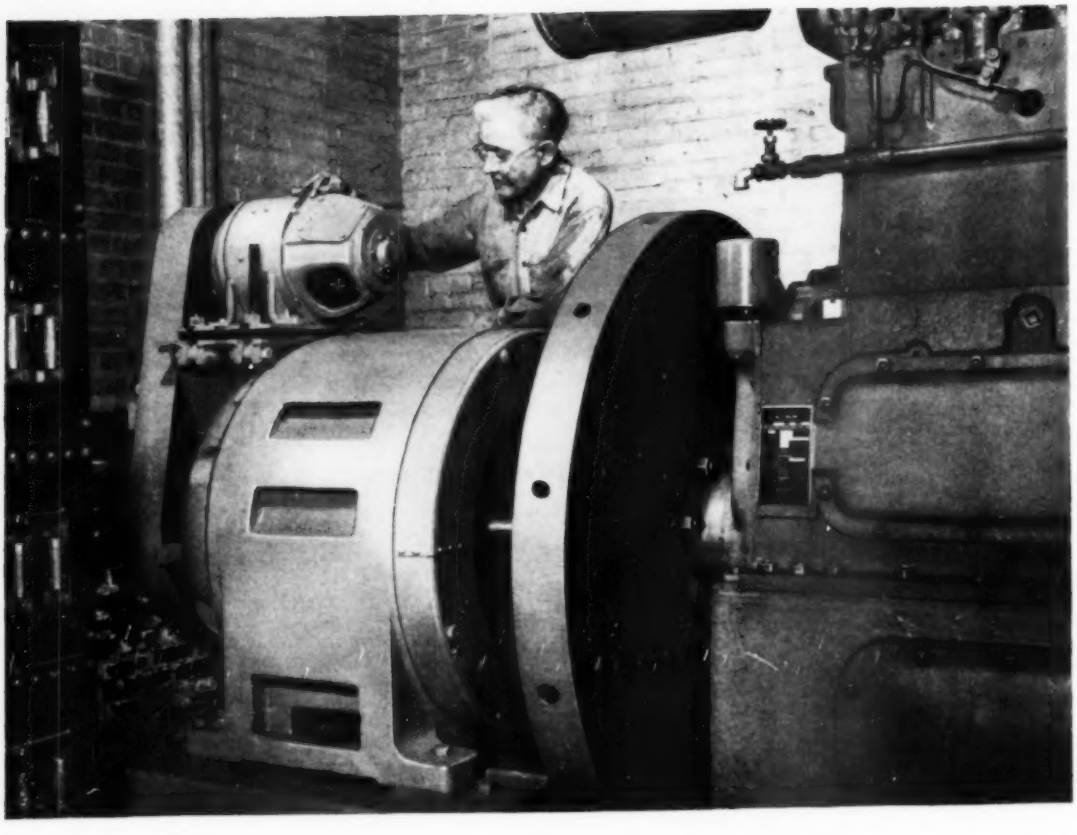
Harrison cooling helps minimize the number and the cost of overhauls . . . it is a strong factor in cutting the *roundhouse* time and raising the *availability* time of Diesel locomotives.

HARRISON

RADIATORS • OIL COOLERS FOR DIESELS

HARRISON RADIATOR DIVISION OF GENERAL MOTORS CORPORATION, LOCKPORT, N. Y.

for Dependability



for Accessibility

choose TRI-CLAD Synchronous Generators

DEPENDABLE

G-E Tri-Clad synchronous generators can be depended upon to give you the right kind of service in your plant when you want it. Whether for continuous or intermittent power output, for auxiliary power or as the sole source of electric power, Tri-Clad goes on conveniently, economically and dependably.

ACCESSIBLE

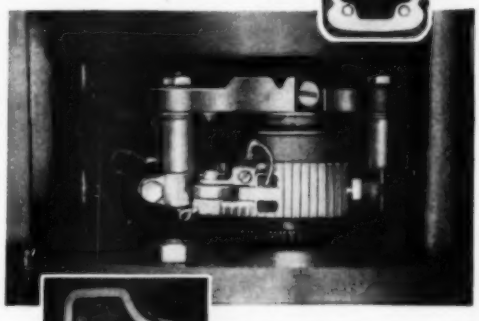
Modifications to fit all installation problems are available with belt-driven or direct-connected exciters. And, once installed, the Tri-Clad generator can be reached with a minimum of effort for maintenance purposes.

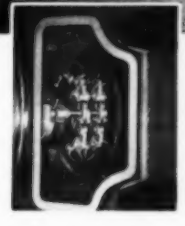
This Tri-Clad synchronous generator is installed in a plant where many production operations require power 24 hours a day, 7 days a week. The generator is on stand-by duty to assure power at any time and is on the job week ends when the regular G-E generator is shut down.

Contact your nearest G-E sales representative for more information. He can give you ratings, modifications and shipment schedules. Apparatus Department, General Electric Company, Schenectady, N. Y.

CONVENIENT CONDUIT BOXES can be turned to any one of four positions for easy connections.

AMPLE ROOM IN EXCITER ADAPTER RING assures easy servicing and brush replacement.





READILY ACCESSIBLE BRUSH HOLDERS can be easily reached through the generous end-shield hand hole.

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Gentlemen:

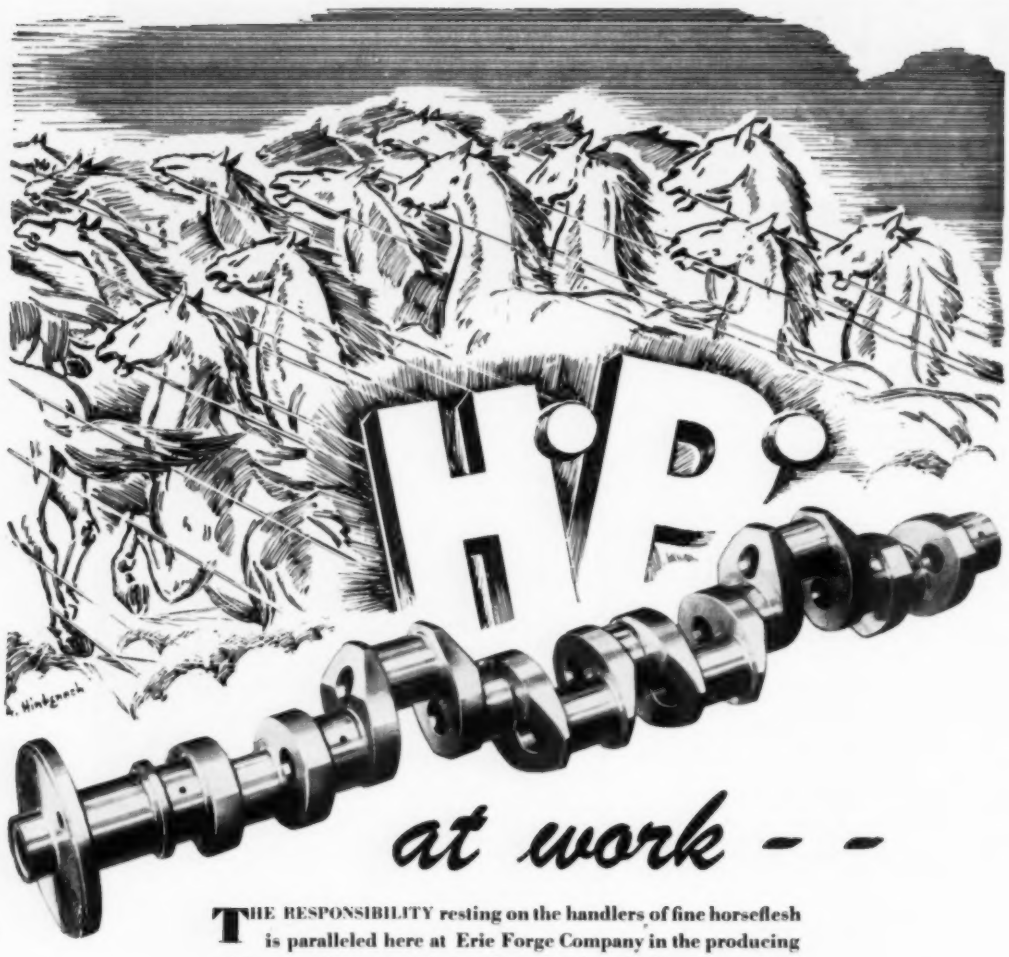
Please send me a copy of GEA-5125 that gives me more information on Tri-Clad high-speed synchronous generators.

Name .....

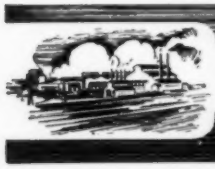
Company .....

Street .....

City ..... State .....



THE RESPONSIBILITY resting on the handlers of fine horseflesh is paralleled here at Erie Forge Company in the producing of fine cranks, connecting rods and drive shafting for putting Diesel Power to work. Design, Engineering, Metallurgical Control . . . Craftsmanship from raw material-working to precision machine-finishing . . . "Know How" gained by years of intelligent, watchful work . . . These are the One Responsibility and One Control you buy when your specifications become finished products at Erie Forge. Submit your specifications . . . we shall consult with you promptly and with experienced eyes . . . . Together we can create a finer product for you.



ERIE FORGE COMPANY, ERIE, PA.

GONE are the "good old days" when a fleeting view of the glories of nature *en route* might be had through clouds of steam and smoke that streamed from the engine up ahead. All accompanied by bone-shaking jerks and jolts at stopping and starting, to say nothing of dirty hands, dirty linen and an occasional cinder in the eye.

* * *

HERE now are the grand new days with such magnificent trains as these *California Zephyrs*. They are operated jointly between Chicago and San Francisco by the Burlington, the Denver & Rio Grande Western, and the Western Pacific. Vista Dome observation affords full, free vision of the scenery amid comfortable and luxurious surroundings. These crack trains are powered by General Motors Diesel locomotives.

"Better trains follow General Motors Locomotives"

GM GENERAL MOTORS LOCOMOTIVES

To be sure of enjoying to the full the new and exciting features that modern railroad travel provides, there is just one thing to remember: Better trains follow General Motors locomotives.

Vista Dome observation permits passengers on the California Zephyrs to enjoy to the full America's beautiful and impressive western country with its gorgeous mountains and broad plains.

ELECTRO-MOTIVE

DIVISION OF
GENERAL MOTORS
LA GRANGE, ILL.

Home of the Diesel Locomotive

SCOTCH DRINKER

INTERNATIONAL DIESELS deliver the maximum amount of work for fuel consumed. As self-contained, independent power units they'll carry power loads within their range continuously. And still they have reserve lugging ability to overcome sudden overloads. In the sensitive speed governor, a torque-boosting device increases engine torque as much as 15% when pulled down by loads. ● "Scotch" with fuel and lubricants, yet tireless on the long grind, these are the power units to fulfill your requirements. Your International Power Unit Dealer can supply the size you need . . . now. Contact him.

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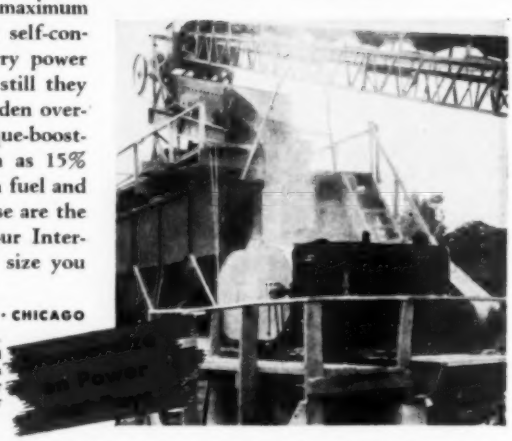

International UD-18A Power Units drive this rock-crushing and screening plant. Securely sealed from the thick dust clouds, these 125-h.p. diesels provide sustained, dependable crushing power at low cost. Get International diesels for your power needs.

Write for Diesel Catalog.

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WHEEL TRACTORS
DIESEL ENGINES
POWER UNITS

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INTERNATIONAL
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Situation well in hand!

Shown at the right, L. E. Madsen, superintendent of the city light and power plant, North Branch, Minnesota, has made important savings through the use of Standard HD Oil. A. F. Moldenhauer, Standard Oil Industrial Representative, shares the superintendent's satisfaction.

Operation improved 3 ways with . . .

HERE'S WHAT the switch to Standard HD Oil, formerly Nonpareil HD Diesel Oil, did for a 300-HP Fairbanks-Morse Diesel engine in the city light and power plant, North Branch, Minn.:

The engine was operated for 3,000 hours on Standard HD. An inspection of the unit and a comparison of lubrication records showed three important improvements brought by Standard HD. *Piston deposits, previously heavy, had been reduced to negligible quantities. Life of filter cartridges had been doubled—increased from 90 days to 180 days. Lubricant consumption had been cut by 22%.*

You can count on getting similar benefits from using Standard HD Oil. This superior lubricant has shown, again and again, that it can improve economy in all types of Diesels and in all kinds of service. It owes that ability to the combination of effective oxidation-resistant and detergent additives with highest-quality base stocks. A Standard Oil Lubrication Engineer will help you obtain the most effective use of Standard HD Oil. Why not write for his services, today?

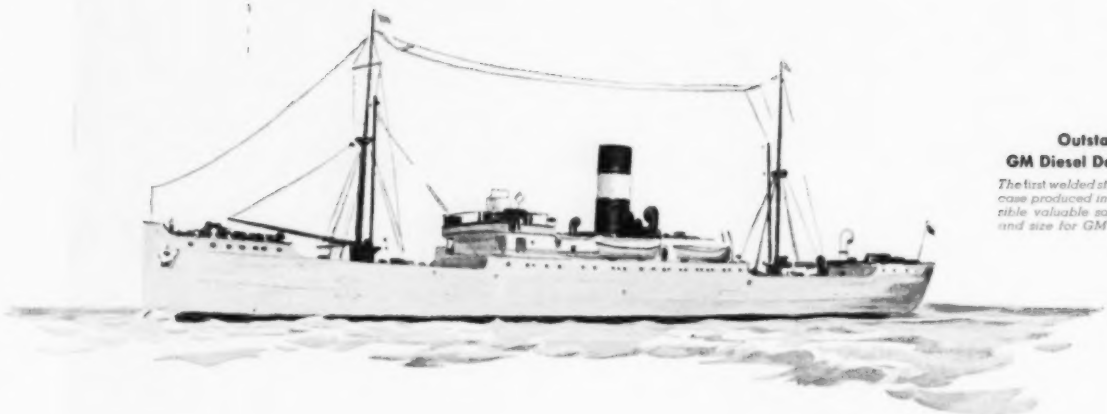
STANDARD HD OIL

FORMERLY NONPAREIL HD DIESEL OIL

Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA) STANDARD

Diesel-Electric solves a weighty problem



Outstanding GM Diesel Developments

The first welded steel Diesel crankcase produced in 1931 made possible valuable savings in weight and size for GM Diesel engines.

Cargo carriers have discovered that a General Motors Diesel-Electric Drive more than pays its way—with low-cost operation—dependable, fast-accelerating power—increased maneuverability. GM Diesel's smaller space and lighter weight provide more room for toting tonnage.

GM GENERAL MOTORS DIESEL POWER

ENGINES FROM 150 TO 2000 H.P.

Leader in Diesel engineering development for 37 years

CLEVELAND DIESEL ENGINE DIVISION

CLEVELAND 11, OHIO

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Also Manufacturers of: ROLLER BEARING TEXTILE SPINDLES
WINDSHIELD WIPERS FOR AIRCRAFT, TRUCKS AND BUSES • FUEL OIL PUMPS
FUEL OIL INJECTORS • PRECISION PARTS AND ASSEMBLIES

In a Wisconsin quarry operation, this Gardner-Denver air compressor has the protection of a Purolator Oil Filter

Don't let a chip off the old block ruin engines . . .

Rock chips, dirt, and dust are sure to hit an engine's oil stream in a quarry operation such as this. The problem is to filter them out completely before they reach the engine and do a wrecking job on vital parts.

The solution—*a Purolator Micronic Oil Filter, of course!*

Purolator's exclusive micronic element traps particles measured in microns (.000039 of an inch) . . . and has a revolutionary accordion-pleated design which provides a filtering area 5 times that of old-style oil filters.

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Write for details—and be sure to consult our highly experienced engineering staff about your *special* filtering problem.

Protect your Power with Purolator!

PUROLATOR
MICRONIC OIL FILTER

PUROLATOR PRODUCTS INC.

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Dependable Power with KOPPERS K-SPUN Piston Rings

THE tough grind of scheduled service on the Alcan Highway is another recent experience that demonstrates the superiority of Koppers Piston Rings. They have set new records for dependability and economy in airliners, Diesel locomotives, ocean-going tugs—every kind of service on land, sea, and in the air.

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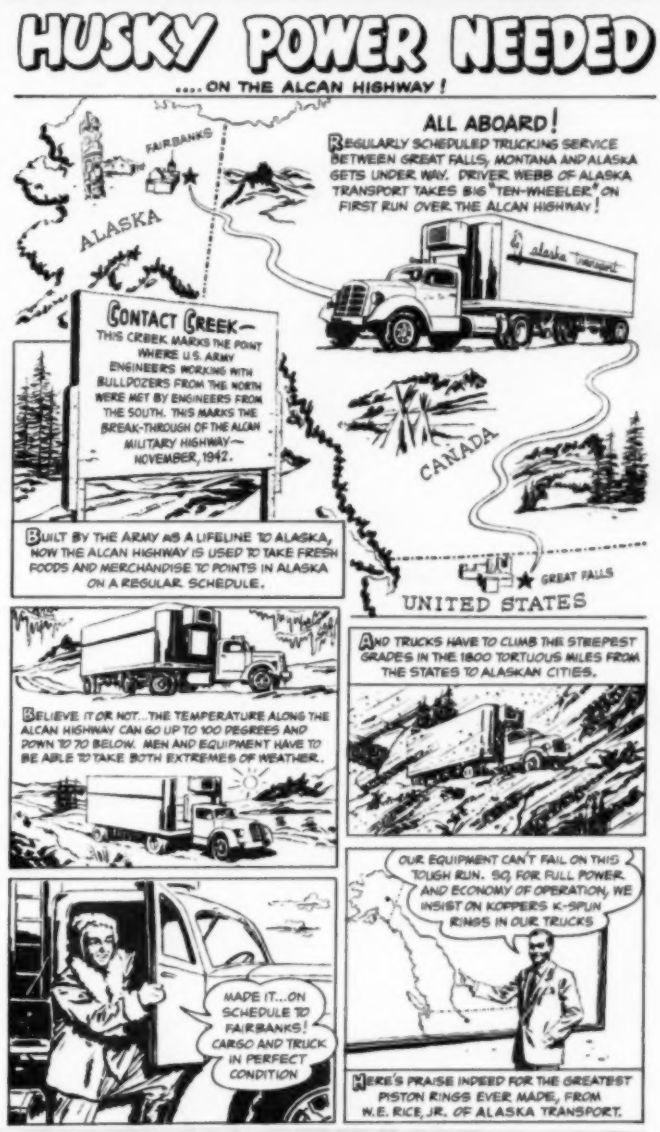
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ALASKA
CONTACT CREEK—
THIS CREEK MARKS THE POINT WHERE U.S. ARMY ENGINEERS WORKING WITH BULLDOZERS FROM THE NORTH WERE MET BY ENGINEERS FROM THE SOUTH. THIS MARKS THE BREAK-THROUGH OF THE ALCAN MILITARY HIGHWAY—NOVEMBER, 1942.
CANADA
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GREAT FALLS
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AND TRUCKS HAVE TO CLIMB THE STEEPEST GRADES IN THE 1800 TORTUOUS MILES FROM THE STATES TO ALASKAN CITIES.
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HERE'S PRAISE INDEED FOR THE GREATEST PISTON RINGS EVER MADE, FROM W.E. RICE, JR. OF ALASKA TRANSPORT.

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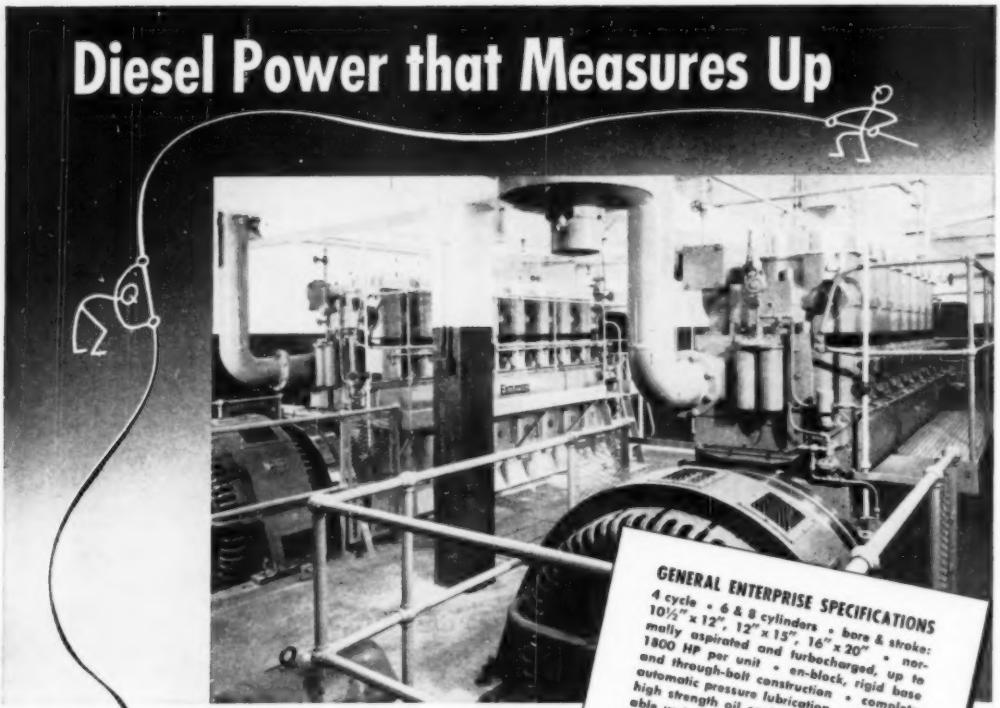

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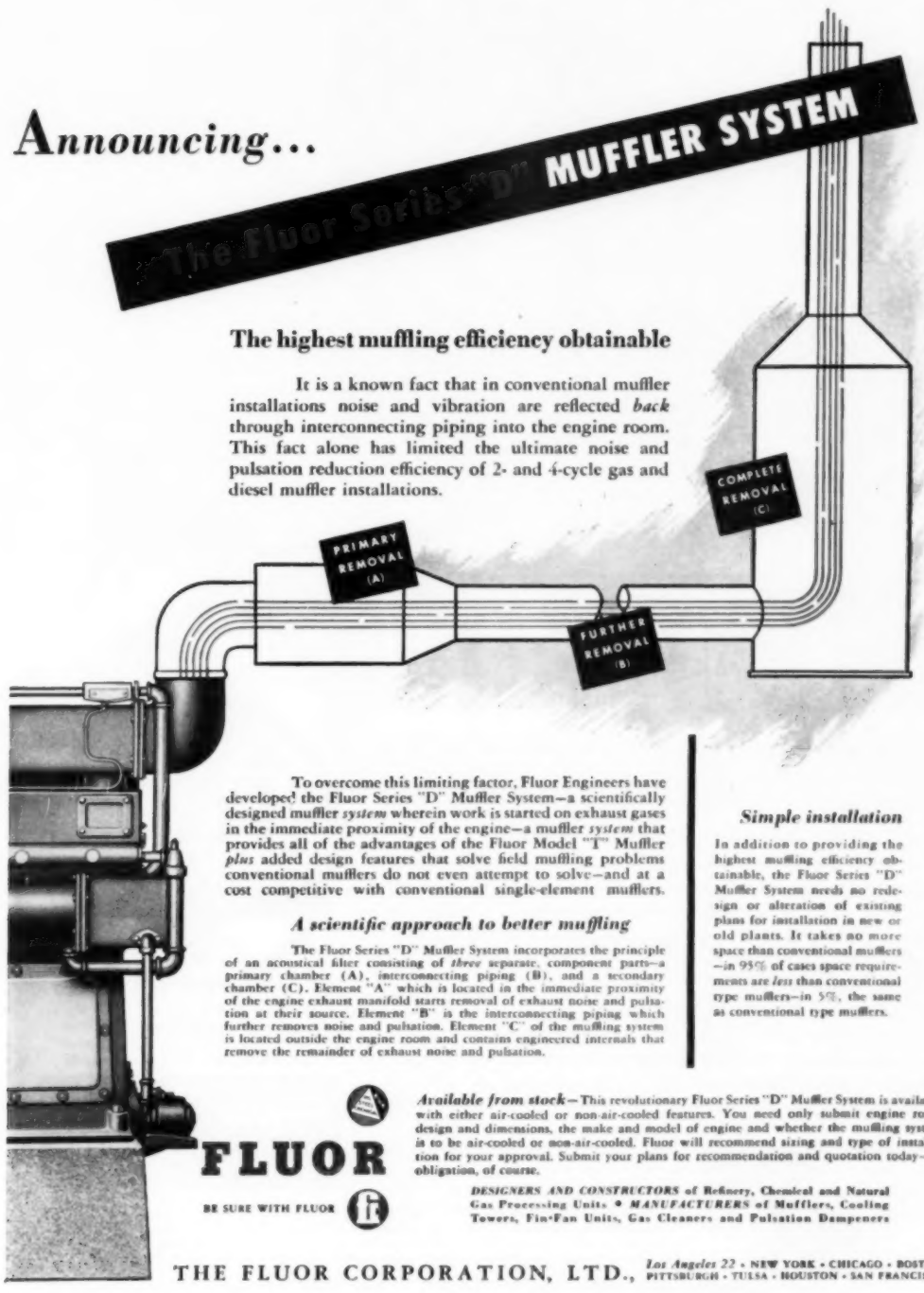
The Fluor Series "D" MUFFLER SYSTEM

The highest muffling efficiency obtainable

It is a known fact that in conventional muffler installations noise and vibration are reflected *back* through interconnecting piping into the engine room. This fact alone has limited the ultimate noise and pulsation reduction efficiency of 2- and 4-cycle gas and diesel muffler installations.



To overcome this limiting factor, Fluor Engineers have developed the Fluor Series "D" Muffler System—a scientifically designed muffler *system* wherein work is started on exhaust gases in the immediate proximity of the engine—a muffler *system* that provides all of the advantages of the Fluor Model "T" Muffler *plus* added design features that solve field muffling problems conventional mufflers do not even attempt to solve—and at a cost competitive with conventional single-element mufflers.

A scientific approach to better muffling

The Fluor Series "D" Muffler System incorporates the principle of an acoustical filter consisting of *three* separate, component parts—a primary chamber (A), interconnecting piping (B), and a secondary chamber (C). Element "A" which *is* located in the immediate proximity of the engine exhaust manifold starts removal of exhaust noise and pulsation at their source. Element "B" is the interconnecting piping which further removes noise and pulsation. Element "C" of the muffling system is located outside the engine room and contains engineered internals that remove the remainder of exhaust noise and pulsation.

Simple installation

In addition to providing the highest muffling efficiency obtainable, the Fluor Series "D" Muffler System needs no redesign or alteration of existing plans for installation in new or old plants. It takes no more space than conventional mufflers—in 95% of cases space requirements are *less* than conventional type mufflers—in 5%, the same as conventional type mufflers.

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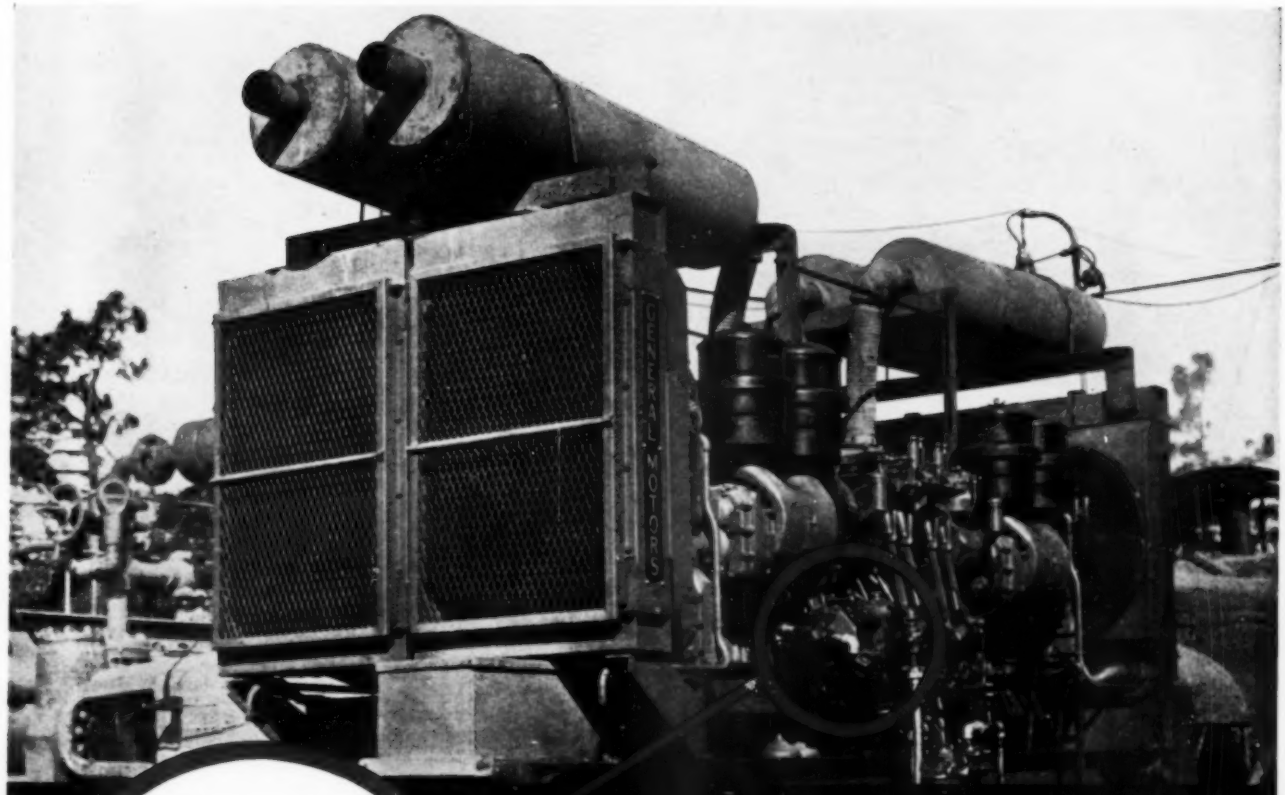

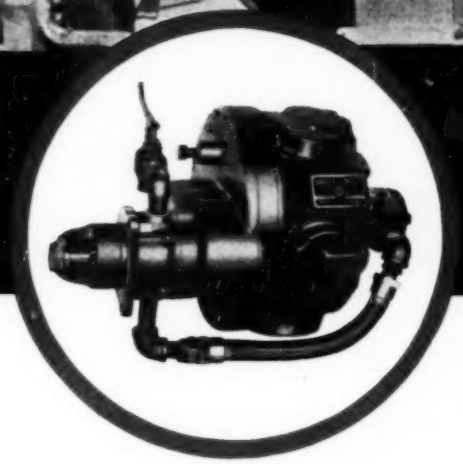

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Sure, safe starting without costly battery maintenance and replacement! That's why Gardner-Denver Air Starters provide the *modern* way to start your Diesels. Here are the reasons why they give greater reliability and economy to Diesel performance:

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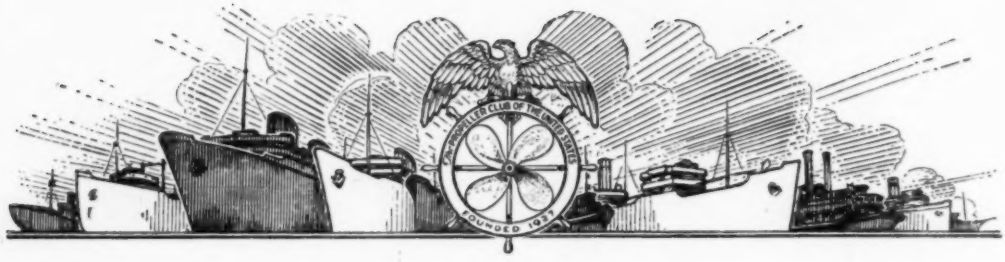

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Requirements and Responsibilities of American Shipping

THE American Merchant Marine Conference, sponsored by The Propeller Club of the United States in conjunction with its Twenty-Third Annual Convention, will be held in New York, October 19, 20 and 21st, 1949.

The Conference theme will be "Requirements and Responsibilities of American Shipping." Problems of vital concern to the American Marine Industry growing out of the period of world reconstruction and the rehabilitation of our domestic and foreign trade will be presented and discussed by recognized authorities. The Conference will concentrate the experience and wisdom of outstanding leadership upon subjects of utmost importance affecting the future of the American Merchant Marine.

Panel Discussion meetings will be held on October 19, 20 and 21st; the joint Convention-Conference Luncheon on Thursday, October 20th; Propeller Club Convention Session on Friday, October 21st; and on the evening of that date, the annual American Merchant Marine Conference Banquet.

The necessity for constructive and coordinated effort is more apparent today than ever before. . . Your cooperation and participation are needed in this program to foster the best interests of the American Merchant Marine as an essential factor in the national defense and our economic welfare. . . Arrange now to attend the American Merchant Marine Conference and to take part in this important annual gathering of the American Marine Industry.

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THE WALDORF-ASTORIA – NEW YORK

October 19, 20 and 21st, 1949

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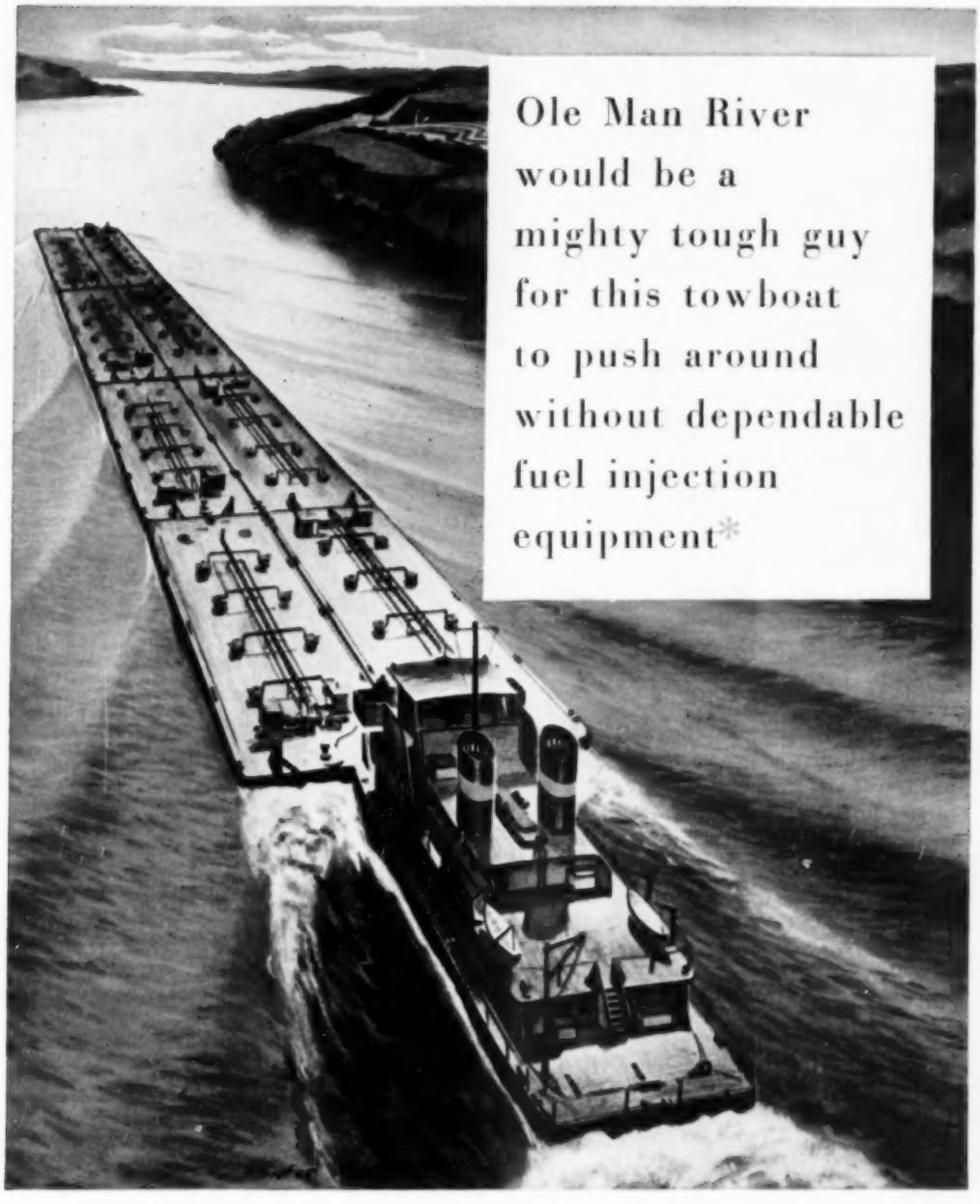

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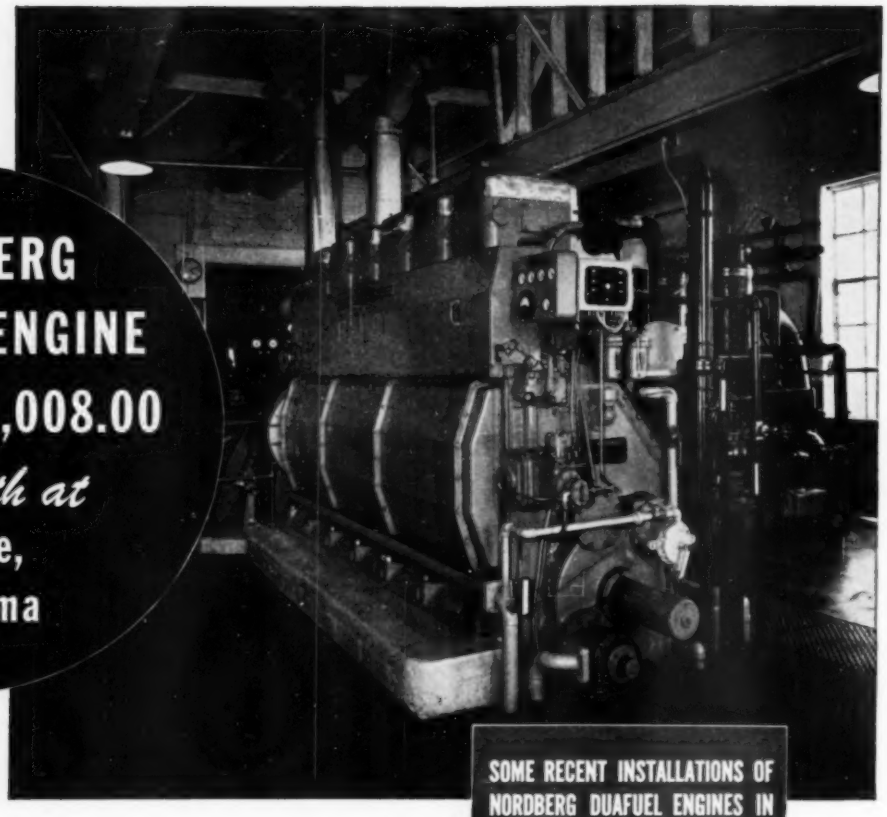
NORDBERG DUAFUEL ENGINE *Saves* $1,008.00 *per month at* Okeene, Oklahoma



MUNICIPAL service at Okeene, Oklahoma, has grown from an annual generation of 640,760 K. W. in 1916 to 2,850,550 K.W. in 1948. Prior to last year's installation of an 840 H.P. supercharged Nordberg Duafuel Diesel engine, all power was generated with oil burning Diesels.

Plant Superintendent Sam Isbill reports that for the month of June, the Nordberg Duafuel Engine, burning gas fuel, saved $1,008.00 in the cost of fuel and lube oil compared with the oil fuel and lube oil cost of the oil burning Diesels. With this performance, the new engine will soon pay for itself in savings.

Speaking of the Nordberg Engine, Mr. Isbill states, "Our Nordberg Duafuel engine is doing a fine job and is showing a big reduction in operating expense."

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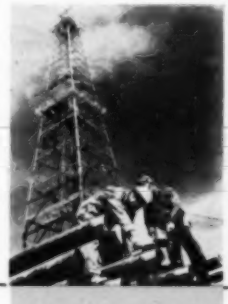

FRONT COVER ILLUSTRATION:

Huge derrick of the record breaking wildcat well, Pacific Creek No. 1, silhouetted against the Wyoming sky.

Story on Page 28.

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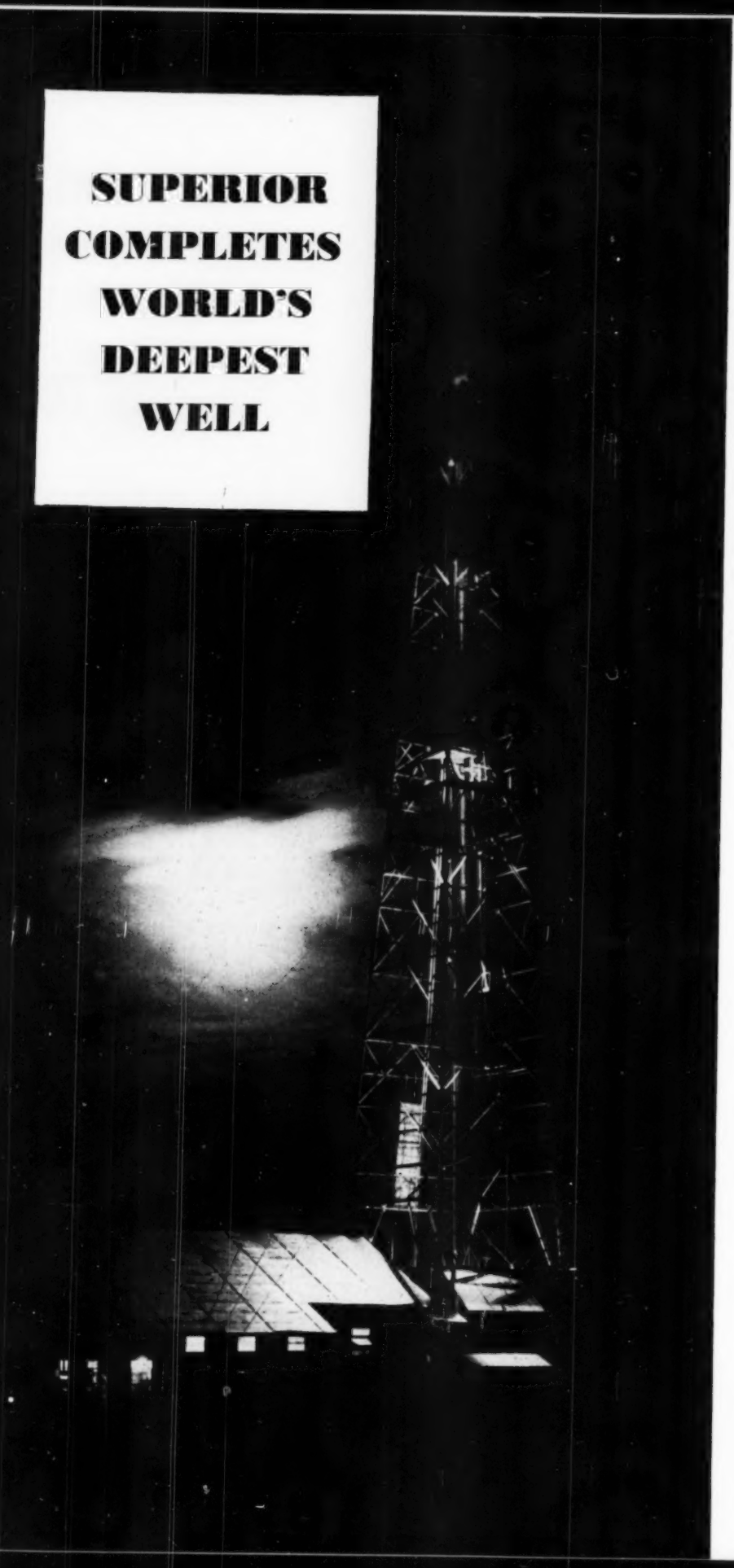
SUPERIOR COMPLETES WORLD'S DEEPEST WELL

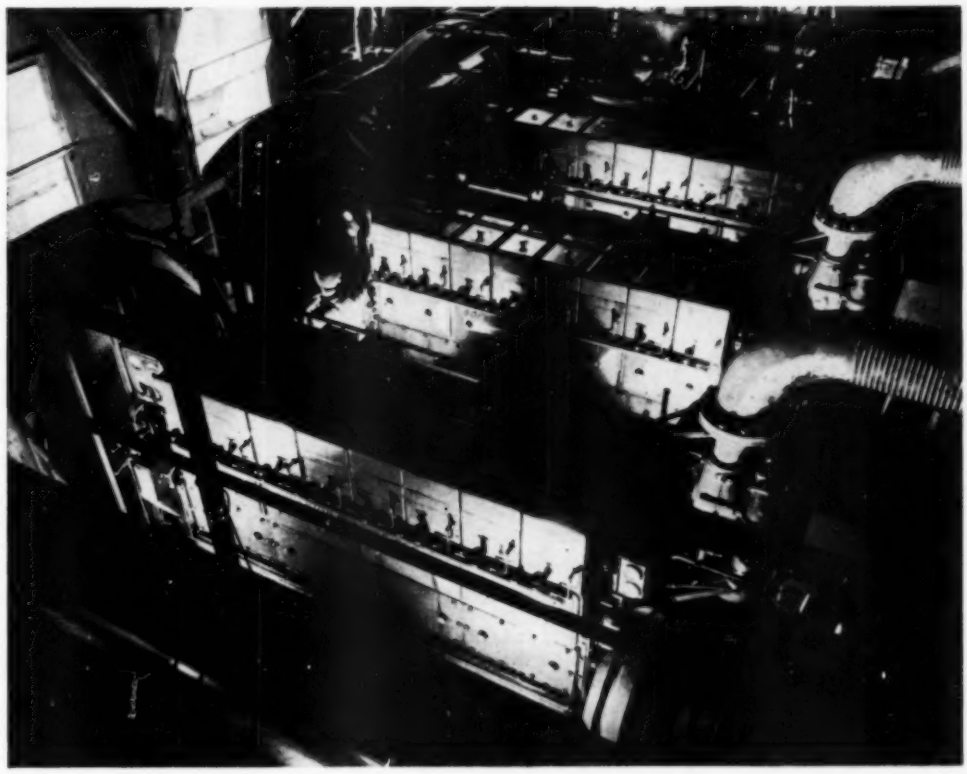


FOR years past oil men, particularly those concerned with oil production, have speculated on the possibility that some day, somewhere, a well would be drilled to the depth of 20,000 feet. Within the experience of many men still active in the industry, a 10,000-foot well was something to excite wonder, and as late as 1932 only a dozen such wells had been sunk in the entire world. Theoretically the attainment of this or even greater depths was feasible, but the practical difficulties became steadily greater as the line of drill pipe grew longer and the cost of the operation multiplied with the depth.

With the continuous growth in the size and power of drilling rigs and the constant improvement in operating methods, the depth record moved to higher and higher figures. It was a noteworthy event when the 15,000-foot mark was passed in 1938, and as the investment rose to a half million dollars for a single dry hole, it began to appear that a financial rather than a physical limit would set the final boundary for such undertakings. Still the adventurous spirit of the probers of the earth's depths was not quenched. Year by year the bit reached further down and the depth record passed from state to state, from California to Texas, to Oklahoma and back to California again. When the 18,000-foot mark was passed, confidence grew that within the near future the combination of persistent effort and favorable conditions would lead to the record that had seemed but a distant dream only two decades ago.

Early in June the word was flashed that the 20,000-foot level had at length been broached and on June 17 Superior announced a final depth of 20,521 feet. The record goes to none of the states that have been holders of such marks in recent years, but to Wyoming, a recognition of the growing importance of the Rocky Mountain area in the general oil picture. The well is Superior Oil Company's Unit No. 1 in the Pacific Creek area of Sublette County near the Sweetwater County line. Its location is officially described as SW NE SW 27-27N-103W on the northeast side of the Green River basin.

Oil and gas possibilities in the deep portions of the Green River basin have been of great interest since the discovery of gas by Mountain Fuel Supply Company in the Church Buttes field in the southwestern part of the basin, at 12,500 feet in Dakota sands in 1946. The discovery followed extensive geophysical work in the area by Mountain Fuel, and there have been further geophysical surveys since that time. The Pacific Creek wildcat is located on a line of Tertiary folding south and west of the Wind River Mountains and north of the Baxter Basin anticline. A very thick layer of Tertiary overlays the area, much thicker than expected following seismic work in the area. In addition to the Pacific Creek deep test, several other wildcats are now scheduled in this area of Wyoming to depths below 12,000 feet. The majority of prospects are located on Tertiary structures, confirmed with seismic work. At the present time Stanolind Oil and Gas Company is drilling a deep test on a large surface Tertiary structure in the Canyon Creek area, along the Colorado-Wyoming



Three Superior supercharged diesels. These drilling engines supply power to the rig and pumps and the combined output is 2010 horsepower. Two similar engines are used for additional power slush pump.

line on the south side of the Green River basin, and others are planned in the vicinity of Pacific Creek area.

Discoveries in the Church Buttes field, at Worland, Washakie County, and at West Poison Spider, Natrona County, where oil is produced from Frontier sands at 14,309 feet, indicate that an era of deep basin drilling is now under way throughout the numerous basins of the Rocky Mountain region and prospects seem good.

Drilling of Pacific Creek No. 1 was began in July 1948, as soon as the rig was dismantled after being shown at the May International Petroleum Exposition at Tulsa and reerected in Wyoming. Drilling was continued through the bitter weather of last winter by four six-man crews. In one of the worst blizzards the company snow-plow once was unable to get through at the normal relief time, and one crew stayed on the job 24 hours.

Actual drilling was began at a depth of 9,881 feet where a previous operation had been suspended in November 1947. Since the old hole was only nine inches in diameter, it was first reamed to 12¼ inches and then drilled to 9,929 feet where 9⅝-inch casing was set. From this point an 8⅜-inch hole was drilled to 19,765 feet where seven-inch pipe was set. A total of 497 joints of 26-to-29-pound SAE 4340 was run in the well in 23 hours, after which 1,000 sacks of cement were pumped down.

Plastic coated drill pipe was employed to minimize corrosion. The drilling operation was largely uneventful. The accuracy of the automatic feed-off was such that bit consumption was low. Only 177 bits were used between 9,929 feet and 19,765 feet. At depths around 20,000 feet the operation proceeded at an average drilling rate of fifty feet per day.

It is appropriate that the drilling of the world's deepest well was done by the world's largest diesel powered rig designed especially for deep penetration. The outfit which attracted much attention when first displayed at the Tulsa oil show last year by the National Supply Company includes an Ideal consolidated rig powered by three Superior dual-fuel diesel drilling engines with 2010 combined horsepower. Two pumps, rated one at 825 and one at 495 input horsepower, are driven from the three-engine drive group. An additional E-700 pump is independently driven by two engines identical with those on the drawworks. The rig has a combined horsepower of 3350, almost the equivalent of two main-line diesel locomotives. Hoisting equipment, including a seven-sheave, 630-ton crown and a six-sheave, 540 ton traveling block used with a 1½-inch wire line, represents the largest of its kind ever built.

One of the greatest improvements to be incorporated in a modern power rig is the drive from engines to drawworks and pumps through hydraulic couplings. These couplings, called Ideal gyrol fluid drives, are mounted adjacent to each engine on the engine extension shafts. An adjustable sliding scoop can vary the amount of fluid in the coupling and can completely empty it, thus eliminating the necessity for an engine disengaging clutch. The scoop, which is air operated by the driller, regulates the amount of fluid in the coupling and, therefore, the degree of slip. By varying the engine speed and the slip of the coupling, a very wide range of speed and power is available for the pumps, drawworks and rotary.

An example of one of the advantages offered by the gyrol fluid drive was realized during reaming from the surface pipe to a depth of 9,881 feet. The rig was set up over an old nine-inch hole and reamed to 11 inches. The rotary table was operated with a high transmission speed ratio, the speed being reduced by slipping the No. 1 engine coupling, thus limiting the power transmitted to the table. When torque built up in the string due to excessive cuttings or cave-ins, the coupling slipped completely, stalling the table and eliminating the danger of a twistoff. This conditon was actually encountered several times.

The Lee C. Moore derrick incorporated in the rig has an overall height of 215 feet from concrete footings to top of ginpole. Overall width of the engine foundations is 48 feet and the main skids are 39 feet long. The power sub-structure is 5 feet 6 inches high and the drawworks bench 6 feet high.

Because of the severity of weather anticipated during the period in which the well was being drilled, the engines, mud pumps and heating boiler were all enclosed in a gable-type steel building.

Superior has been among the oil companies most active in deep exploration. Within the past two years the company has set three successive depth records. In 1947 its Weller 51-11 in Caddo County, Oklahoma, was bottomed at 17,823 feet. In March of this year it abandoned Limoneira No. 1 in Ventura County, California, at 18,734 feet, while almost at the same time Pacific Creek No. 1 surpassed this figure and went on probing new and untried deeps.

FREE PISTON GAS GENERATOR BRIGHTENS GAS TURBINE FUTURE

By LISLE F. SMALL

Editor's Note: This paper was given before the S.A.E. summer meeting at French Lick in June, by Lisle F. Small, Executive Engineer of the Lima-Hamilton Corporation.

THE gas turbine appears to be destined to become an important factor in the production of power on land and on sea. However, this forecast is based on neither past achievements nor present trends, but rather on the faith and enthusiasm of gas turbine advocates. The natural laws which apply are too involved for our imperfect comprehension, so that they lure us on rather than guide us toward a rational course of development. Cold facts and figures, which could stand up to the scrutiny of criticism of unbiased engineers assembled here, just cannot be produced at this present stage.

The success of the aircraft gas turbine in jet propulsion and turbo-prop units has been phenomenal and it is quite natural that in seeking new worlds to conquer its proponents and fellow travelers have invaded the field of power production on land and on sea. Here, however, the gas turbines must be competitive economically with the modern steam plant unless favored by special conditions such as exist, for instance, in the Houdri process where fuel is a by-product. Generally speaking, there exist no unique advantages making the fuel bill a secondary consideration.

Actually, the development of the industrial and marine gas turbine has been seriously impeded by the existence of certain unsolved technical and economic problems. The fact that we have gone so far without properly appraising these difficulties is due to the fact that they are peculiar to land and sea forms of turbines and do not occur in the aero-turbine which, until recently has received the lion's share of research effort.

Basically, every gas turbine plant must consist of only three elements—a means of precompressing air, a combustion chamber for burning fuel in that air, and a turbine to convert the energy of the gases leaving the combustion element into the mechanical energy of a rotating shaft. A modern turbo-prop aero-plant most nearly approaches the simplicity of this description. A gas turbine plant of the original classical simplicity was actually built in 1940 to drive an emergency electric generator installed in a bomb-proof room in Neuchatel, Switzerland. It has performed very well, but its thermal efficiency is low, 16-18%, which, for an emergency plant, is not too important. One basic feature of this plant characteristic of the "open cycle" type is very important and it should be well understood.

With an external output of 4184 KW, the compressor of this plant absorbs 11,480 KW so that the gross turbine work amounts to the sum of these two, or 15,664 KW. The compressor work is thus 2.74 times, and the turbine work is 3.74 times, the maximum net external output of the whole plant. It should be noted that most of the power developed by the gas turbine goes for compression of air, only a small part of which is needed for combustion. The rest of the air is required to dilute the products of combustion in order to reduce their temperature below the limit at which the turbine blading material can handle these gases. Useful work is not begun by the products of combustion until their temperature has been degraded.

The cardinal sin of this cycle, known as the open cycle, is excessive dilution made necessary because the available materials for the turbine blades cannot live in higher temperatures. Therefore, the cycle cannot possibly render a competitive efficiency unless the temperature of the gases entering the turbine can be increased by many hundreds of degrees. In other words, physical limitations of the turbine are a major factor in depressing a theoretical attainable thermal efficiency. But note well the utter simplicity of the open cycle turbine plant with consequent light-weight, moderate bulk and probable reliability of performance all highly desirable.

As one would suspect, the simplicity of the original basic gas turbine plant subsequently has been violated by the addition of improvements in the form of such auxiliaries as regenerators, dual compressor with intercoolers, reheaters, multiple turbines, etc. Every new addition or modification has created a new "cycle" and improved somewhat the thermal efficiency, but the real hope of the open cycle gas turbine is in blading and rotor materials capable of withstanding gases of 2000° F. or even higher. In the meantime, ingenious means of cooling the turbine blades, ceramic coating of steel turbine blades, and even ceramic alloyed blades, are being investigated by many research personnel.

New and better temperature-resistant materials for gas turbines are being developed constantly, they also are becoming more and more expensive and more difficult to obtain, especially in sizes required for rotors. Every indication points to the national necessity of avoiding competition with the aircraft turbine industry in the procurement of what amounts to definitely limited quantities of these alloys of rare metals. One very fundamental method of improving this critical situation is to devise ways and means of producing the same external load of the plant with smaller turbines. In other words, a reduction in the required quantities of these precious alloys is a positive corrective measure for this situation.

In discussing gas turbines, we must not forget that our real experience with this type of prime mover still rests on the operation of thousands upon thousands of exhaust gas driven turbo-chargers of internal combustion engines, gasoline aircraft engines, as well as industrial and marine diesel engines.

The handicap imposed upon the development of gas turbine by the lack of a plentiful supply of heat-resistant materials, has been overcome by the ingenuity of the French engineer, Pescara, who in his U. S. Patent declared that the chief object of his invention is to provide motor compressors capable of producing a compressed and superheated gas. The first Pescara Gas Generator was constructed at the Als-Thom Company plant at Belfort, France, and was first placed in operation in May, 1939, carrying designed full load by the following October.

Generally speaking, a Pescara Gasifier or Free Piston Gas Generator, consists of a highly supercharged diesel cylinder, all of the power of which is used to compress the atmospheric air required for scavenging the charging of this cylinder. There is no excess of power over the internal requirements of the unit. Except for the inevitable losses to the coolants of the cylinder and the pistons, the entire energy developed by the combustion of the fuel is divided between the work of compression and the energy in the hot compressed gasses leaving the working cylinder. The preferred construction of the unit and one used by Pescara and others to date, utilizes the well-known advantages of the opposed piston type of diesel engine. These include the efficiency of the uniflow scavenging and the perfect balance of the reciprocating masses in addition to the minimum of cooled wall surfaces of the combustion space to reduce heat losses and increase thermal efficiency. There being no rotating crankshaft to restrain the motion

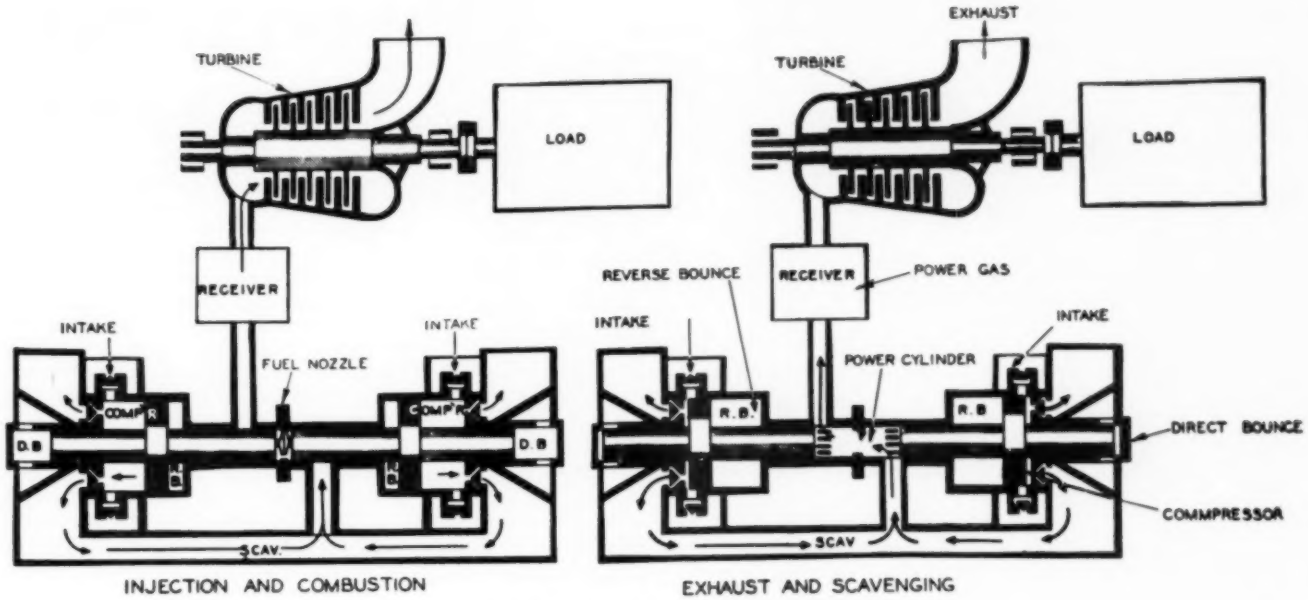


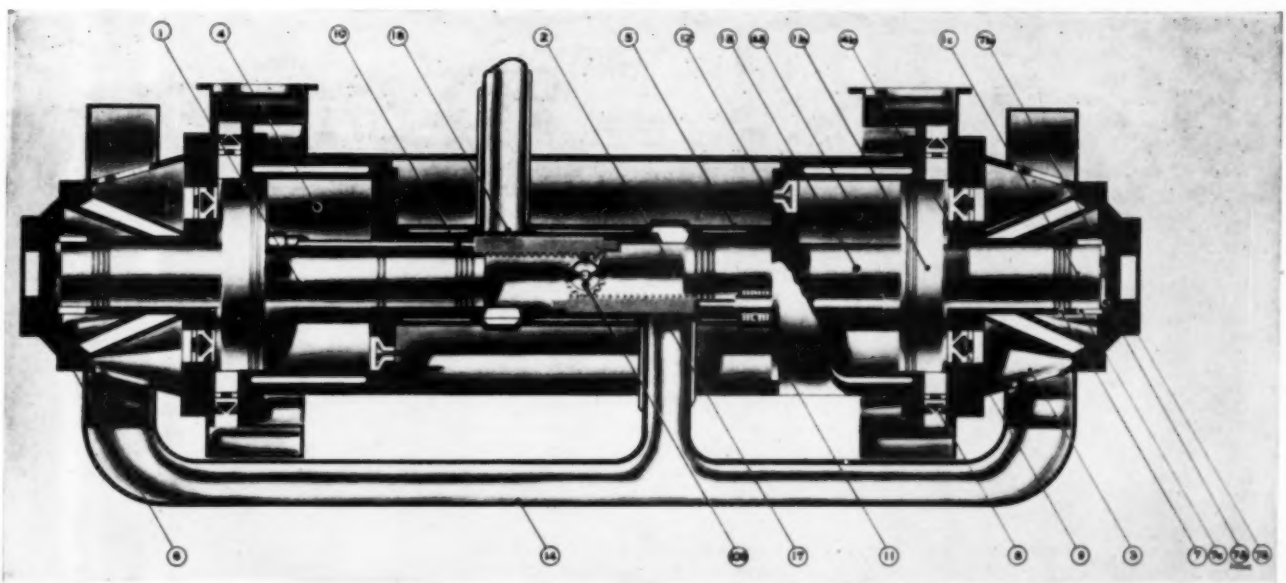
Figure 1—Free piston diesel-turbine unit diagram.

of the piston and, therefore, no flywheel for storing excess energy of one stroke for use during the subsequent one, the free piston construction requires that there be a balance of energy for every stroke, so that each piston can come to rest at the end of each stroke. The combustion of the fuel charge with the pistons in their innermost positions at the end of the compression stroke supplies additional new energy to cause the pistons to fly apart rapidly. The escape of combustion gases at the end of the expansion stroke followed by their replacement by a cooler air charge, gives, controlling effect to the energy stored in the bounce spaces or cushions to drive the pistons together on their compression stroke. These bounce spaces or cushions serve to maintain substantially constant compression pressure while varying the charging pressure and piston stroke by controlling the energy stored in them through the weight of air trapped therein, which is alternately compressed and expanded.

Figure 1. shows schematically a Gas Generator connected to a Gas Turbine with the pistons in both of their extreme running positions, while Figure 2.gives an enlarged schematic section of the Free Piston unit itself. The power cylinder is very much like that of an opposed piston Diesel engine. It has open ends, ports adjacent to its ends, and fuel nozzles on its center radial plans.

Figure 2—Schematic Diagram of a Free Piston Gas Generator.

1. Piston Assembly
1a. Power Piston
1b. Compressor Piston
1c. Bounce Piston
2. Power Cylinder
3. Scavenge Air Receiver
4. Compressor Cylinder
4a. Reverse Bounce Space
4b. Compressor Space
5. Power Cyl. Liner
6. Direct Bounce Head
7. Direct Bounce Space
8. Compressor Inlet Valves
9. Compressor Disch. Valves
10. Synchronizing Rack
10a. Synchronizing Pinion
11. Stuffing Box
12. Dump Valve
14. Scavenge Air Duct
17. Inlet Ports
18. Exhaust Ports



Relatively large diameter compressor pistons are on the outer ends of the power pistons. The face of these pistons away from the power pistons compresses and delivers air for scavenging the power cylinder. The space adjacent to the power piston is designated as a reverse bounce chamber used primarily for governing the unit. This space figures prominently in starting the unit with compressed air. The outermost end of each piston assembly operates in a direct bounce space whose primary purpose is to store sufficient energy during the firing stroke to return the piston assembly to a proper compression position after the space between the two power pistons is properly scavenged. At all times the two piston assemblies are maintained symmetrical with respect to the center radial plane of the liner by synchronizing racks attached to the compressor pistons and the synchronizing pinion located on the frame of the unit. This symmetry precludes any free forces. The principal duty of this synchronizing gear is to drive and time the fuel injection pumps.

Regarding the motion of the free pistons. First, this motion is perfectly definable and calculable and it is just as constant as that of any pendulum, because the free piston is a pendulum of constant mass and subject to definite and unchangeable elastic recovery forces of compression within the combustion cylinder on one end and within the bounce cylinder on the other, which remain unchangeable as long as the weight of air being compressed in these spaces is not changed to meet different load conditions. The pistons thus are not free in the strict sense of the word, neither are they "rampant" as some joker, lacking either the time or the inclination to analyze the situation, has put it, but on the other hand, neither are they "chained" and forced to move to suit a crankshaft heavily loaded by the inertia of rotating and reciprocating masses attached to it which must maintain uniform rotation because of that. We have chosen the pendulum to measure time for us, hence our so-called "free piston" pendulum is an equally reliable timing device to maintain frequency in cycles per minute (CPM).

The reasons for optimism about the future of the gasifier-turbine combination are based on the fact that the gasifier is the natural heir of the diesel engine which served the world for over fifty years as the most efficient power producer, principally because combustion in the diesel cylinder occurs at high pressures and temperatures with very high heat releases. Despite high pressures, high temperatures and high heat releases the combustion chamber of a diesel engine has been developed to such perfection that there is no maintenance problem associated with parts comprising it in a successful design of engine, while in turbojets of modern airplanes and even in all conventional gas turbines, periodic replacement of the combustor is accepted as inevitable as the rebricking of the boiler furnace. The secret of this highly successful performance of the diesel combustion lies in its intermittent operation since every combustion cycle is followed by cooling though expansion and then by scavenging the cylinder with cool charging air for the succeeding cycle. Furthermore, water cooling of the outer walls of the combustion space contributes to its

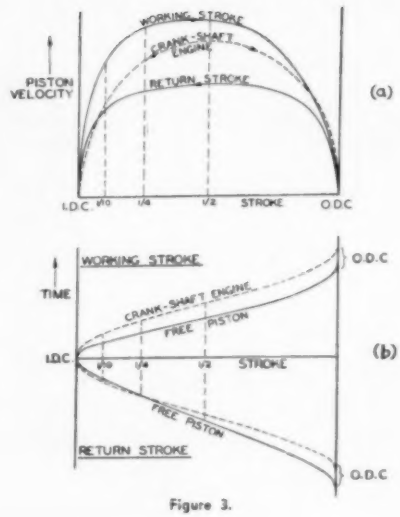


Figure 3.

reliable performance as a source of power.

Combining a gas turbine with a highly-supercharged diesel engine solves a problem of long standing—for years the engineers have been searching for ways of expanding the products of combustion to atmospheric pressure. An engine with a short compression and a long expansion stroke was built but was too complicated to survive. A compound engine with a fixed ratio between low pressure and high pressure cylinders was developed and forgotten. Only turbocharging, using a gas turbine of variable speed, created the ideal compounding partner to the Diesel. From then it was easy to redistribute the duties and assign to the diesel cylinder the load of compression and to the gas turbine the useful load. The turbine running at high RPM with expansion to atmospheric pressure thus recovers some of the energy escaping into exhaust in a normal diesel engine and provides a light and compact means for expanding low pressure gases, while the diesel engine cylinder can best exploit the elevated temperatures resulting from combustion of high energy liquid fuels.

The peculiarities of the free piston motion also contributes to the superlative efficiency of the gasifier-turbine combination. The frequency of it rises with decrease in piston weight with consequent increase in gasifier output and horsepower of the turbine. But lower weight of piston also causes its greater acceleration under the impact of pressure developed by combustion so that the temperature of the gases drops faster during the early part of the stroke and less heat is lost to cooling medium with consequent improvement of thermal efficiency. Efficiencies well above 40% have been obtained by the Pescara group and on our test stand. Careful study of Figure 3. will clarify the above mentioned superiority of free piston motion over harmonic motion of the crank connected piston.

What has been accomplished to date in the development of the free piston unit? The French Pescara group has built a number of gasifiers of several designs, vertical and horizontal, symmetric and asymmetic in the arrangement of compressors. Their latest type, the tests of which were published by Dr. Eichelberg, has many admirable design features which contribute to its simplicity and to its reliability of performance. The use of a low pressure bounce chamber to receive all of the physical energy of each combustion to be divided on the inward compression stroke between the compressor and the compression in the power cylinder, not only shortens the unit, but makes it easier to maintain than the high pressure bounce chamber of Lima-Hamilton design. It is not proposed to continue, in this article the enumeration of the refinements which resulted from several successive redesigns of the original Pescara unit, but merely to invite readers to careful study of the published information and the test results.

The road of discovery, in whatever field, can always be recognized by the "bleached bones" of those who failed to make the grade, for it takes not only courage but extraordinary endurance to sustain the voyager. The gasifier road is no exception and several failures to find the path to the realization of advantages predictable from theoretical deductions, are to be recorded. Sulzer Bros., for instance, built a 7000-hp gasifier-turbine plant suitable for merchant ship propulsion, thoroughly tested it and decided that it would be unable to compete commercially with the more conventional type of gas turbine plant. Pratt and Whitney spent much money and effort developing a gasifier-turbine plant for aircraft propulsion, but came to the conclusion that the difficulties offered by operation above 20,000 feet elevation required too much research and laid it aside temporarily to switch to a less efficient solution more promising of immediate results. Several British similar developments are reported to be in a state of "suspended animation."

The Lima-Hamilton Corporation and the Pescara group in France appear to be the principal active exponents of the gasifier-turbine combination as the most efficient way of producing power and potentially the most compact and light plant.

Finally, it must be added that to date, development has generally been limited to single cylinder Free Piston Gas Generator units with ingenious arrangements in the blue print stage for multi-unit application. If the development of the internal combustion is to repeat itself, the perfecting of the multi-cylinder gasifier is the next order of business.

Proposals for larger total horsepower, which have become known to date, contemplate installation of a substantial number of such single cylinder gasifiers into a small number of manifolds connecting to one or more turbines.

Here again, if the history of the successful development of the Buchi turbocharger is to be a guide, exhaust ducts serving two gasifiers timed to exhaust 180° apart should be used. Three or four pairs of such gasifiers properly timed with respect to each other should be mounted on a common frame and constitute one gasifier bank with a three or four duct arrangement connecting it to a turbine.

TEST STAND FOR FUEL INJECTOR PUMPS

By DWIGHT ROBISON

TEST stands for the testing of diesel equipment that are compact and practical always find a large and appreciative market. The one described in this article has been in process of development for a long time and is now being sold on the market in large quantities.

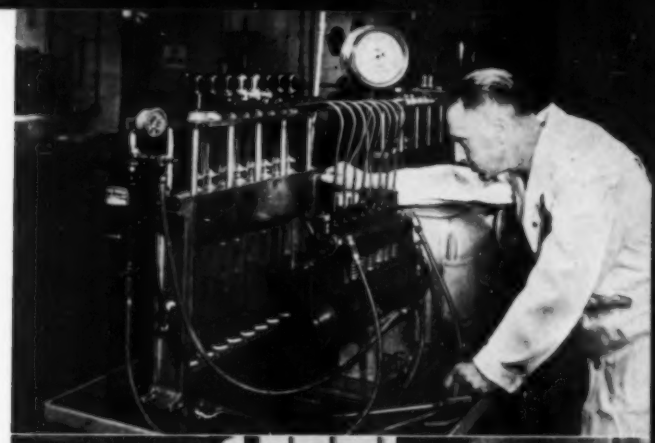
The designers of this unique piece of equipment first made it for use in their own shop but large users of diesel equipment who saw it asked for similar stands and consequently they soon found themselves in the manufacturing business.

The first crude stand merely measured the amount of fuel injected into one cylinder but development has produced precise equipment that not only measures the fuel injected into as many as eight cylinders simultaneously, but also checks governor operation, makes it possible to set minimum and maximum speeds before the pump is installed on the engine, checks for leaks and shows pressures. All of these tests and adjustments are performed while the test part is mounted on the stand.

So far as is known, this is the only test stand of its kind being manufactured at the present time and it is being distributed to all parts of the United States, Asia, South America and the Hawaiian Islands and is being used by leading manufacturers of diesel equipment in their laboratories.

The test stand described and illustrated in this article was designed and is produced and marketed by Automotive Products, Incorporated of Portland, Oregon.

A special power operated stand is used to test spray pattern. Fumes and oil spray are drawn through spun glass filters in back. With the use of this stand nozzles can be adjusted under conditions similar to actual operation.

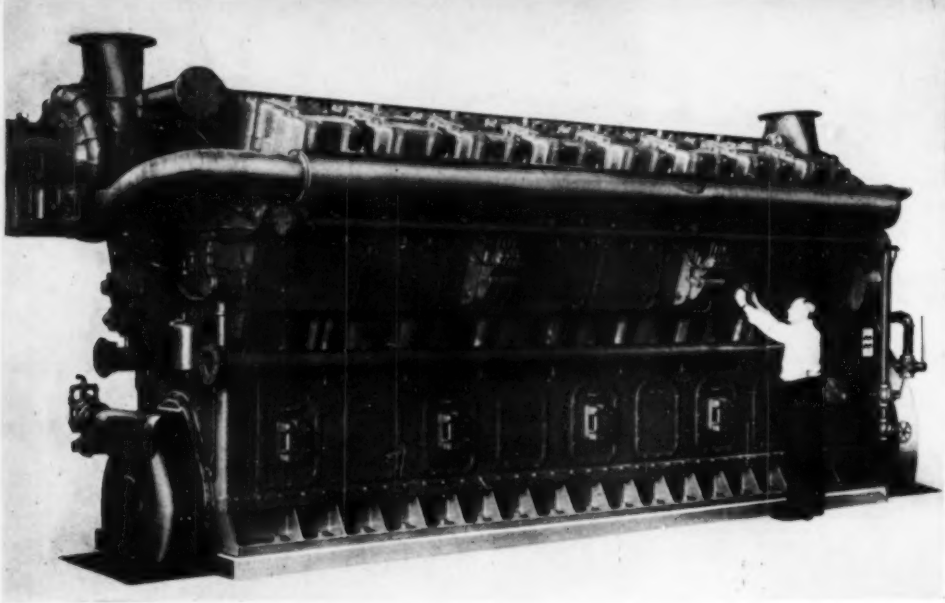


As soon as the diesel fuel injector pumps enter the shops they are thoroughly cleaned and then checked for governor operation, accuracy of fuel delivery and overall performance on the test stand. Note the unequal amount of fuel in the calibrating cylinders indicating that nearly twice as much fuel was pumped into one cylinder as another.

After being checked the pump is attached to a special swivel-type work stand where it is completely dismantled, cleaned, repaired and re-assembled. This stand is so designed that the pump may be turned or tilted to any position and held rigid.

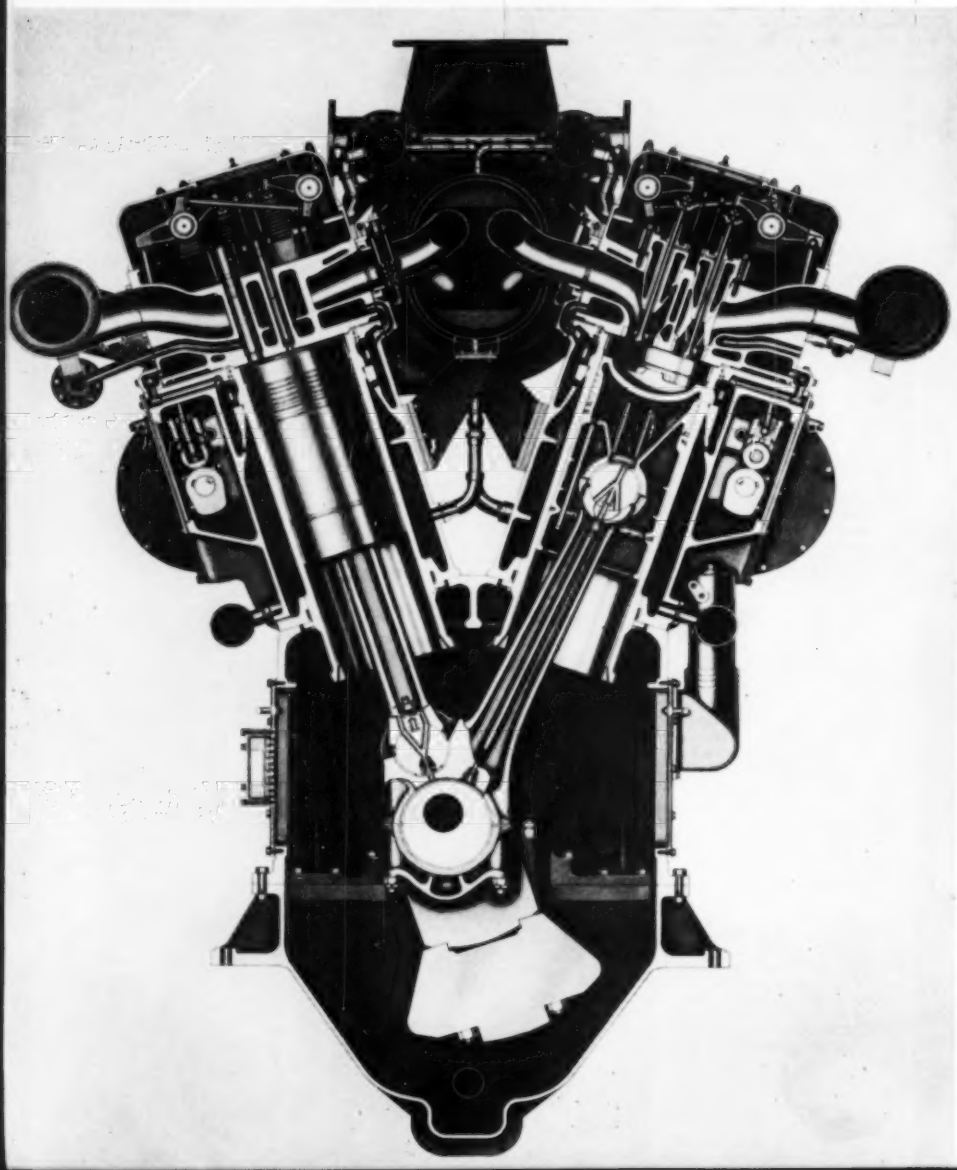
Nozzles are disassembled, checked, repaired and reassembled. Here a mechanic is lapping in parts prior to assembly.

After the pump has been re-assembled, it is again mounted on the test stand where adjustments in the amount of fuel injected into each cylinder are made until it is within a fraction of a percent of being identical. Next the governor is set to proper operating speed, delivery valves are checked for proper operation and the whole pump mechanism is tested for leaks. A variable speed drive makes it possible to set idling and maximum speeds while the pump is on the stand.



Sixteen cylinder, turbocharged version of the Cooper-Bessemer Model LSV engine which operates as a diesel burning oil or gas fuel or as a spark ignition engine without changing cylinder heads or pistons.

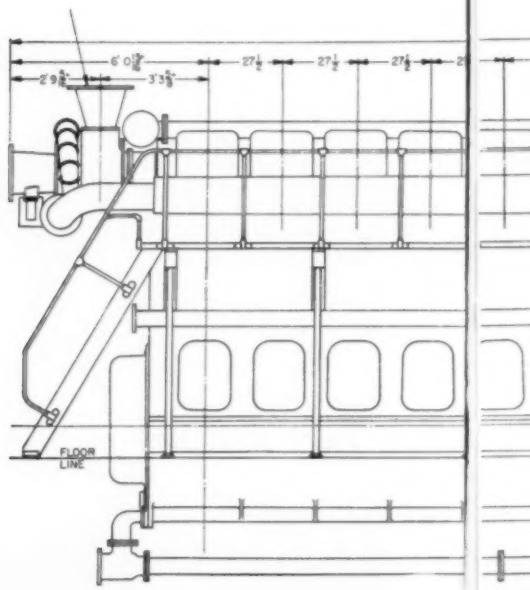
Transverse section through the LSV engine. Note the articulated connecting rod arrangement.



A NEW COMPACT, POWERFUL DIESEL

By WILBUR W. YOUNG

MT. Vernon, Ohio, Aug. 9—A new diesel is always news but recent announcements indicated that Cooper-Bessemer has something more than just another engine. Our visit here today with Vice President and Chief Engineer, Ralph Boyer, confirmed our belief that the new LSV engine is not only unique but it is also the most powerful and compact engine of its type. Better still, it is way past the dream stage—it is a reality, one 12-cylinder version being in actual service, a 16-



cylinder unit having been sold and shipped and more coming through production.

This is a heavy-duty engine, the LSV-16 being rated 3400 hp. at 327 rpm., and it can be operated as either an oil or gas burning diesel or a spark ignition engine. Conversion for any of these three types of operation is accomplished without changing the cylinder heads or pistons.

The two banks of cylinders form an angle of 36 degrees with a blanketed exhaust manifold running through the center of the V. The cylinders are 15½ in. by 22 in., fitted with wet liners. Buchi-type turbochargers, one mounted at each end of the engine, each serve one bank of cylinders, on the LSV-16. A single turbocharger handles the LSV-12. We understand that about 80% of this manufacturer's present production are V-type engines and that the company puts great faith in the future of the Vee design. Certain features indicate an ability to back up this view.

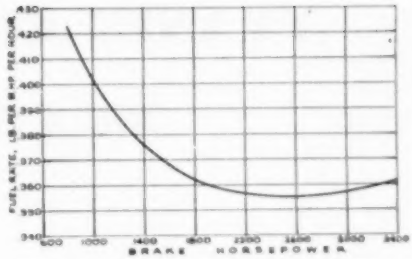
For example, all connecting rods are articulated —thus providing for maximum bearing area and minimum bearing pressures at the same time eliminating the complications involved in staggering the cylinders. Each cylinder block itself is a one-piece casting as are both the center frame and base. These construction features combine to keep the overall length of the engine well below other types of comparable output. An idea of the compactness of these engines may be gained from the company's statement that their output is in the order of 12 hp. per sq. ft. of floor space. This low ratio of floor space to output together with the low overall height of the LSV engines renders them ideally suited to marine layouts for either electric or gear drive and we understand that they will be pushed hard for marine application as well as for stationary power generation, pipe line pumping, etc. The dry weight of the LSV16 is in the order of 57.5 lb. per hp.

A few more interesting details were discovered among which is the fact that oil-cooled cast iron pistons are used and both main and rod bearings are comprised of centrifugally cast meehanite shells with a very thin coating of babbitt. The engines may be fitted with either Cooper-Bessemer fuel injection systems or jerk pumps.

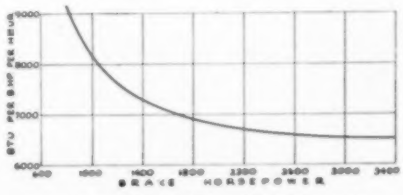
Fuel rates as shown by the accompanying curves should catch the eye of all and sundry who are concerned with the costs of various fuels. For the LSV-16 operating as an oil burning diesel the fuel rate is seen as .360 lb. per bhp. per hour, and for the same engine burning gas fuel, taking the low heat value of gas and the high heat value of pilot oil the fuel rate is shown as 6500 BTU per bhp. per hour.

We freely admit to being mystified by the versatility of these engines whereby they may be converted from diesel to spark ignition without changing the compression ratio but such is the case, we are told, and moreover that smooth operation is achieved throughout the entire load range.

First to take advantage of Cooper-Bessemer's latest engine development are the Arizona-Edison Company, who will soon take delivery of one of the LSV-16 units for their plant at Yuma, Arizona, and the Missouri & Arkansas Electric Power Cooperative. Four LSV-16 supercharged engines are now being built for the latter's new $2,900,000 power plant near Poplar Bluff, Mo. The first dual fuel installation on this network, it will also be the largest of all dual fuel installations so far on the nation's entire R.E.A. system. Each



Fuel rate curve for the LSV engine burning oil fuel.

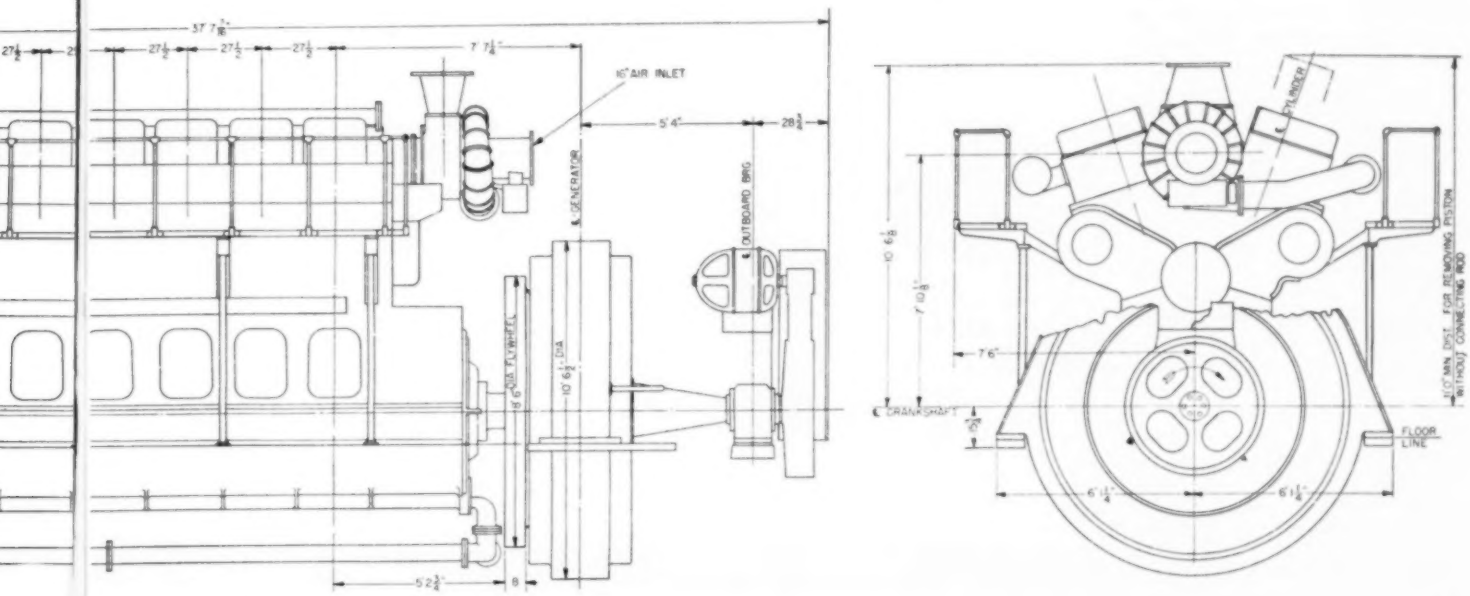


Fuel rate curve for the LSV engine burning gas fuel.

of the four engine-generator units will weigh approximately 100 tons.

The M. & A. network now serves some 25,000 rural consumers and rapidly developing industrial needs in a radius of approximately 150 miles. According to Ansel I. Moore, Executive Secretary of the cooperative, this area's need for electricity is rapidly expanding. For example, studies show that only 55 per cent of the area's farmers are now receiving electric service. This same situation prevails in the majority of the country's farm areas and it is believed that new-type dual fuel gas-diesel engines can in many locations produce power at much lower rates than was heretofore possible.

Dimensional drawing of the LSV-16 emphasizing the compactness o f this engine. Ratio of output to floor space is 12 hp. per square foot.



PLANET GEAR POWER TRANSMISSION IN CRAWLER TRACTORS

By WILL H. FULLERTON

International Harvester 140 drawbar horsepower crawler equipped with hydraulically controlled planetary gear train here shown handling large scraper.

THE use of hydraulically controlled planetary gear trains in crawler tractor drives is new. Consequently curiosity regarding planet power is rife in tractor circles. What is planet power? How do such gears perform? What are the advantages offered by this system? These are some of the questions asked and we have endeavored to answer them in this article.

First let us examine the background of planet gear systems in heavy-duty applications which parallel their use in a powerful crawler tractor. They are used in airplane engines as propeller reduction gears, thus proving their ability to transmit several thousand horsepower in a safe and efficient manner; in winches, hoists and draglines where dead loads subject them to terrific torsional strains; in twin-speed rear axles for heavy-duty trucks, and in certain heavy-duty transmission assemblies. In a modified form, they are used in practically every automobile differential. Then, on the other extreme, they are used in many radio sets where they provide finer, more selective tuning than can be achieved by direct manual control. Why such a wide variety of uses? . . . Simply because planet gear systems offer one of the most efficient methods of variable-speed power transmission known to engineering science.

The use of planet power final drive in a crawler tractor serves two distinct functions—it permits gradual turns with power on both tracks or pivot turns with one track locked, and provides a high-low speed range (both forward and in reverse) without shifting of transmission gears. This high-low speed range, in conjunction with the four-speed transmission and the reverse lever, eight forward and eight reverse speeds.

In operation, the planet power final drive system acts like two dual-speed rear axles, each coupled independently to its respective track, and each hydraulically controlled by a separate lever. Thus, with one control lever in the high-speed range position and the other in the low-speed range position, the tractor makes a gradual turn with power on both tracks. With both control levers in the high-speed position, the tractor travels straight forward in high speed range. The same principle applies with both levers in the low-speed position. A third position of either lever locks the corresponding planet drive and track and puts the tractor into a pivot turn.

Operational convenience of this set-up is immediately apparent. The hydraulically boosted controls of the planet power system are easy to manipulate. The combination of gradual and pivot turning increases tractor maneuverability. The high-low speed range available without shifting or de-clutching is another advantage.

How Planet Gears Work

Planet gear operation is easy to understand. The example illustrated here will show this. Figure *A* is a rear view of an elementary planet gear assembly. Parts included are:—(1) drive bevel pinion which receives power from the transmission; (2) bevel gear which drives the planet gear housing assembly; (3) planet gear housing assembly which is mounted on and turns with the bevel gear; (4) planet gears which are mounted in planet gear housing but which spin freely on their own axes; (5) sun gear which is in constant mesh with planet gears, and which is integral with the tractor final drive shaft.

Let us assume in this example that each of the planet gears has 20 teeth and that the sun gear has 80 teeth. Now when the sun gear (5) is stationary and the planet gears (4) are carried once around it by a single revolution of the planet gear housing assembly (3), it is evident that each planet gear will have to make four revolutions on its own axis (80 divided by 20 equals 4).

Now let us assume that the planet gears can be locked so that they *cannot* rotate on their own

axis. In this condition they are carried around the sun gear (5) by the rotating planet gear housing (3), the sun gear is carried with them and delivers power to its shaft.

Now let us consider what happens when the rotation of the planet gears is "controlled." If permitted to rotate only twice on their *own* axes during one complete revolution of the planet gear housing, it is clear that only 40 planet gear teeth will be presented for meshing with 40 of the 80 sun teeth. Thus the sun gear (5) will be carried through one-half revolution during each complete revolution of the planet gear housing assembly.

This, then, is how the "driving" planet gears operate. By "controlling" the speed at which they rotate on their *own* axes while being carried around the sun gear, any ratio of speed reduction between the planet gear housing assembly and the final drive is possible. This speed control is usually secured by means of "pacing" planet gears integral with the driving planet gear. This will be explained in the following description of the TD-24 planet power final drive.

Figure *B* is an exploded rear view showing the right half of the crawler tractor planet power final drive assembly. Here pinion gear (1), ring gear (2), planet gear housing assembly (3), driving planet gears (4), and driven sun gear (5) correspond to the parts shown in Fgure *A*. We have, however, added "pacing" planet gears (6) and (7) which are integral with planet gear (4) together with their respective independent sun gears (8) and (9). The only function of these pacing planet gears is to "control" the speed of the driving planet gears by means of different gear ratios. Also shown are high-speed range locking disk (10), low-speed range locking disk (11), pivot brake locking disk (12), and brakes (13) and (14).

For clarity, let us now note certain characteristics of this assembly:

1. Planet gears (4), (6) and (7) are an *integral unit* on the same shaft and therefore must rotate at the *same* speed.
2. Sun gears (8) and (9) are *not* connected to the tractor final drive shaft, but are integrally connected to locking disks (11) and (10) respectively by means of sleeves on the drive shaft.
3. The gear ratios between the three integral planet gears and their respective independent sun gears are different. (The ratio between driving planet gear (4) and sun gear (5) is 12:45; between pacing planet gear (6) and high-speed range sun gear (8) is 33:24; and between pacing planet gear (7) and low-speed range sun gear (9) is 24:33.)
4. Locking disk (12) is connected to the drive shaft and is used only for locking this shaft during pivot turns.
5. Locking disk shoes (13) and (14) are so controlled that *only one disk is locked at a time while the other two spin freely.*

With these characteristics in mind, operation of the planet power final drive system should become clear. Let us see what happens when we manipulate the controls that lock each disk.

When high-speed-range locking disk (10) is held, thus stopping sun gear (8), the speed of all three planet gears must conform to that of planet gear (6) as it is carried around its locked sun gear by planet gear housing (3). As the gear ratio between planet gear (6) and high speed range sun gear (8) is 33:24, this will impart a "controlled" speed of 24/33 of a revolution on its own axis to driving planet gear (4) during each revolution of the planet gear housing assembly. As disk (11) and its connected sun gear (9) are spinning freely, they do not oppose the speed of planet gear (12).

When low-speed-range locking disk (11) is braked, thus stopping sun gear (9), the ratio between these gears, 24:33, will impart a controlled speed of 1 9/33 revolutions on its own axis to planet gear (4) for each complete revolution of planet gear housing assembly (3). Now disc (10) and sun gear (8) are spinning freely and do not oppose the speed of planet gear (6).

Note carefully that the *faster* the driving planet gear (4) is allowed to rotate on its own axis the *less* speed it imparts to sun gear (5). Thus when it is making 1 9/33 revolutions for each revolution of planet gear housing assembly (3), the tractor travels 27 per cent slower than when it is making only 24/33 revolutions.

When locking disk (12) is braked, thus stopping sun gear (5), both sun gears (8) and (9) are spinning free and do not oppose the speed of their respective planet gears. In this condition, the drive shaft is locked along with its corresponding track, and all power is delivered to the opposite track. In brief summary, then, planet gears are not new —they have been used for years in critical applications where smooth and efficient variable-speed power transmission is required. They are not complex either structurally or in operation.

The planet gear drive described above is applied in International Harvester Company's 140 drawbar horsepower TD-24 which, it is claimed, is the first diesel crawler tractor to be so equipped.

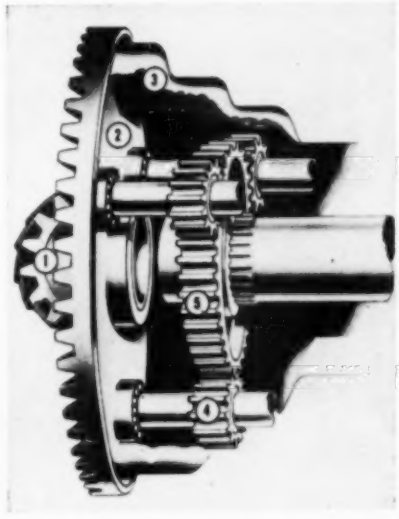
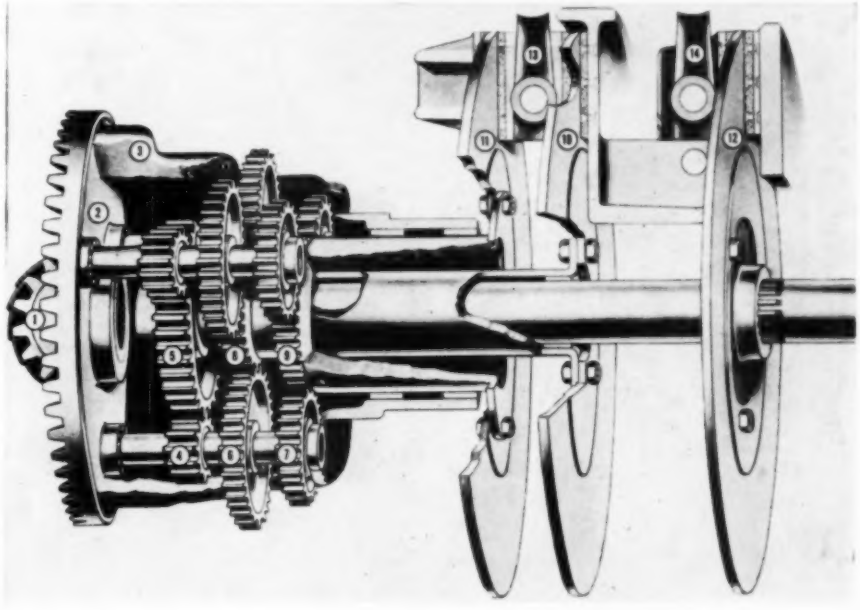


Fig. A—View of an elementary planet gear assembly.

Fig. B—Exploded rear view of right half of crawler tractor planet power final drive assembly.



IMPROVEMENTS

ON

DUAL FUEL ENGINES

DESCRIBED in this article are two improvements on dual fuel engines which will be of considerable interest to our readers. The result of extensive research and experimentation over a prolonged period by the Worthington Pump and Machinery Corporation, it is claimed that the new Dual Plunger Fuel Pump and the Automatic Thermal Air Control provide greater efficiency and smoother operation over a wide load range in dual fuel diesels.

DUAL PLUNGER FUEL PUMP

The injection pump serving the power cylinder of a dual fuel, gas-diesel must be able to adequately perform two functions: first, to accurately meter and inject the small quantity of pilot oil required for the most efficient operation of the engine when using gas fuel and second, to be instantaneously capable of handling the total quantity of oil required when the engine is running entirely on liquid fuel.

The proved advantages of an individual injection pump for each power cylinder are as important on a dual fuel engine as they are on an oil-diesel. Perfect timing and controlled cylinder load balances are not obtainable by any other type of injection system. The Worthington dual plunger injection pump is of this type.

Essentially it is two pumps built in one casing. The cross-section (Fig. 1) clearly shows the construction features.

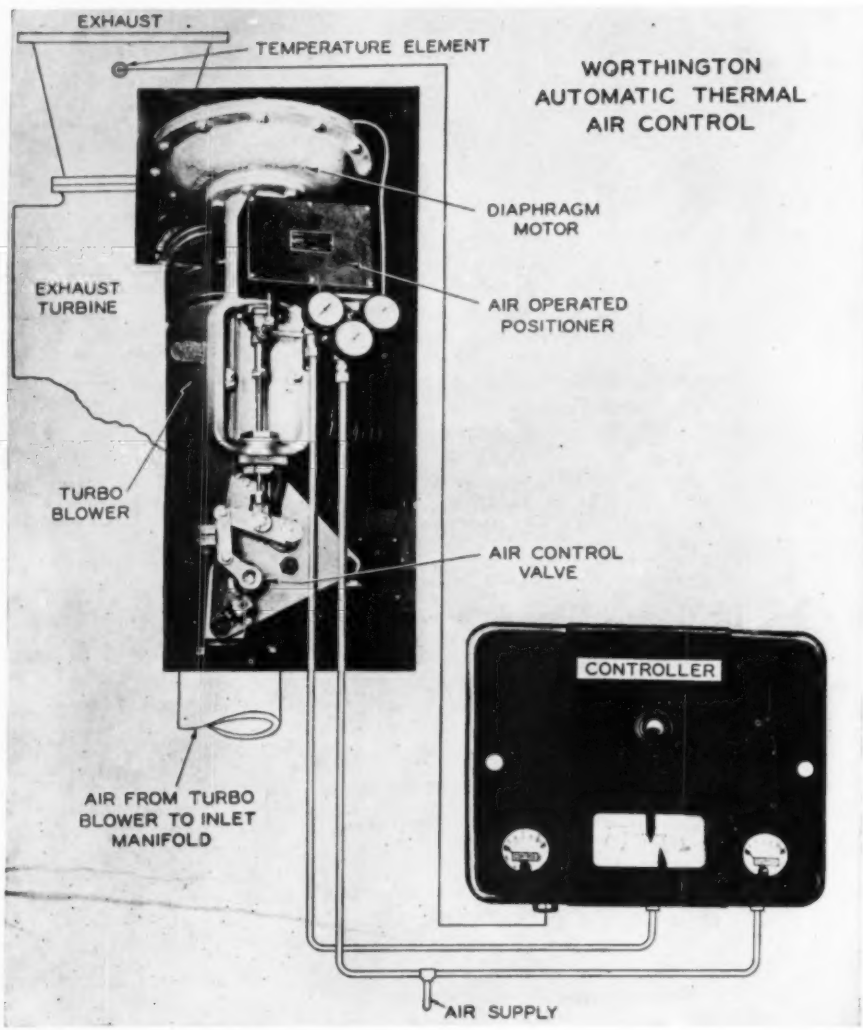
A small diameter pilot plunger, (A) mounted non-rigidly on the top of the main plunger, (B), is actuated by it. The connection between these two elements is designed to compensate for any eccentricity between the pilot plunger cylinder barrel, (C), and the main plunger cylinder barrel (D). Parallelism between these parts is assured by good manufacturing technique.

When the unit is operating as a pilot pump only, the main rack position is at zero. The plunger assembly is actuated by the fuel injection cam through its full travel.

The pilot injection quantity is determined by the length of the pilot plunger from its top end to the circumferential groove at (E). A hole, drilled axially, through the center of the pilot plunger communicates through radial holes to this groove.

Fuel is delivered to the injection pump at suction inlet (F) by a gear type oil transfer pump at sufficient pressure to fill the pilot cylinder barrel when the plunger is in the bottom stroke position. During the upward stroke, this fuel is bypassed back to the suction side of the system until the pilot plunger closes the drilled port passageway (G), after which fuel is discharged through the delivery valve until the port (G) is uncovered by the upper edge of the circumferential groove. Then, the delivery valve returns to its seat and the excess fuel is bypassed through the drilled passages in the pilot plunger back to the suction side of the system.

When operating on oil fuel only, or with propor-



tions of gas and oil in excess of the pilot requirement, the governor will actuate the main fuel pump racks to the desired setting. The total oil fuel used will then be the constant full stroke capacity of the pilot plunger plus additional oil—delivered by the main plunger to meet the load demand. In other words, for full engine load operation, the total oil fuel delivery is the displacement of the pilot area over the full pilot plunger stroke, plus the annual area between the pilot and main plunger diameters. It will be noted that this full stroke capacity of the pilot plunger is considerably greater than the pilot fuel quantity when the main plunger is not delivering any oil.

The full stroke capacity of the pilot plunger, plus the minimum delivery of the main plunger is less than the amount of fuel required to maintain rated engine speed at no load.

AUTOMATIC THERMAL AIR CONTROL

The Thermal Throttling Principle—Turbocharged dual fuel and standard gas-diesels will operate with improved fuel economy with a controlled reduction of the air supply to the engine cylinders at partial loads. This results from:

(a) Improvement in Air-Fuel Ratio Research ha shown that the "lean" limit for flame propogation in hydrocarbons of the paraffin series is an air fuel ratio of 45 to 1. Less air at partial loads improves this ratio and, consequently, the combustion characteritsics.

(b) Reduction in Scavenging Air Cooling unlike the oil-diesel, the gas-diesel will operate more efficiently at partial loads with higher mean cylinder temperatures. The reduction in the scavenging air cooling resulting from thermal throttling control, provides higher cylinder temperature and more complete fuel combustion.

THERMAL THROTTLING CONTROL – Research has determined that for best engine performance, exhaust temperatures should be maintained at plus or minus about 50° F. from a constant mean, as the load is reduced. The Worthington automatic thermal air control makes use of this characteristic. Briefly, this control functions as follows:

A thermometer bulb inserted in the exhaust-turbine outlet is connected to an automatic controller by means of capillary tubing filled with an inert gas. Changes in the exhaust temperature (due to load variations) cause a pilot air valve to operate the servo-mechanism. This diaphragm motor and positioner move the damper through a linkage, in response to a changing air pressure supply from the controller—in this case, closing the valve as the temperature is lowered. Engine starting air—at reduced pressure—is used as the power media.

CONTROL SETTING—The thermometer bulb located in the exhaust turbine outlet, will indicate a temperature of approximately 700° to 750° F. at nominal full load—with a fully opened air throttle. The controller is set to fully open the damper at 700° F., selected to correspond to this nominal full load exhaust temperature.

When the engine is started, the damper is in the closed position. It will remain there until the load causes the exhaust temperature to reach a predetermined point—when, acting through the controller, diaphragm motor and damper positioner, it will reposition the damper to maintain the proper air-fuel ratio. This selection and automatic damper positioning varies continually with load changes and maintains the optimum air fuel ratio at all times.

It is claimed that the Worthington Automatic Thermal air control has the following advantages:

(1) The correct air-fuel ratio is supplied to the engine cylinders at all times and in direct relation to all load changes.

(2) The most responsive medium (engine exhaust temperature) is utilized to actuate this control.

(3) Daily and seasonal ambient air temperatures can be compensated for by simple—and quick—adjustment of the controller setting.

This last feature makes it possible to automatically vary the load carrying capacity of the engine in direct relation to ambient temperatures; a result impossible to obtain with any other type of automatic controller.

The illustrations in this article are through the courtesy of the Worthington Pump and Machinery Corporation.

A) Small diameter plunger

B) Main plunger

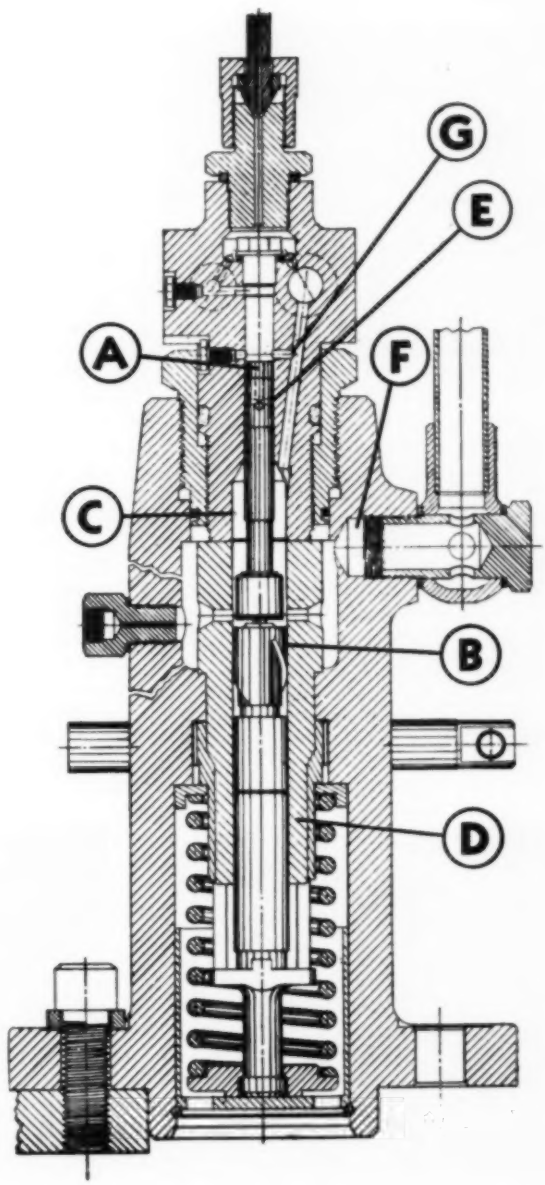
C) Pilot plunger cylinder barrel

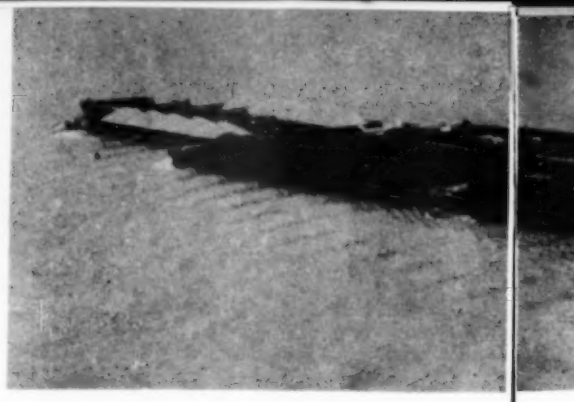
D) Main plunger cylinder barrel

E) Circumferential groove

F) Suction inlet

G) Port passageway





CENTRALIZED CONTROL ON INLAND TOWBOATS

By R. R. STEVENS*

EVERY few days a motor vessel slides down the ways. It is not necessarily a new boat. However, her power plant probably has been transformed, and she has been fitted with personalized control. She is representative of a revolution that has been going on quietly on the rivers.

Within a relatively few years, a number of events have taken place which have changed the pattern of the inland water fleet. The diesel engine provided a stepping stone. Refrigeration contributed its share. Radio gave an impetus to efficiency. Radar offered another step in enabling cargo to keep moving. Horsepowers have increased and are still increasing. Now, new engine controls have been added that bring the control of the whole boat to the master's finger tips.

A river boat is a phenomenal device. A representative vessel might be described as a boat about 150 ft. long. Its engines are most likely to be diesel and totaling something like 2000 hp.

This boat can travel by itself and be self-sufficient for extended periods. Its real duty, however, is to associate with barges and move bulk cargo over long distances. In such a combination, the bargest are connected to the boat so that the entire assembly is one vessel. This unit is then commonly as long as the Queen Mary, or in other words over 1000 ft. long. An interesting example is illustrated at the head of this article showing the *Wade Childress* of The Mississippi Valley Barge Line Company, during her acceptance tests.

Unlike the *Queen Mary*, the river tow requires no assistance from sources such as tugs for anything it has to do. It can dock. It takes care of its own handling through locks. It passes through tortuous channels in a winding river that make the feat almost incredible. Furthermore, it may do this 24 hours a day and every day except when floods or frozen rivers interfere.

Pilot house controls are an important part of this background. The use of pneumatic controls has probably provided the most spectacular part because of its effect on precedents. Pneumatic controls have taken the movements for control from a task for the bulldozer to finger tip category. They have provided a uniform timing. They have preserved a proper sequence of events in engine behavior, regardless of any impatience in operation. They permit the captain to confidently control his ship. Pneumatic controls have added a new skill and confidence in vessel handling.

Pneumatic controls have simplified the installation as compared to mechanical linkage. They have also greatly reduced the cost of maintenance. An unexpected supplement to saving has developed in another direction. It has been found that pilot house controls supplied have reduced accidents. Pilot house controls have been applied to every general classification of diesel power, this including reversing engines, reversing gear, and electric drive. Reference to a few illustrations of typical types will provide a means of outlining several different phases of current modernizations.

Figure 1 illustrates the console in the pilot house of the M/V *Frank C. Rand*, of The Mississippi Valley Barge Line Co. She is equipped with National Superior reversing engines. It will be noted the Radar is immediately in front of the pilot for his convenience, and flanked by controls for steering, searchlights and engines. All the functions of an engine are embodied in one lever. The control lever is movable in a straight slot, except for side starting notches forward and aft of the neutral position. After an engine is started, its speed is controlled by the position of the lever in the slotted quadrant. In reversing, it is possible to move the control lever into the reverse start notch. However, starting air will not be admitted to the engine until the camshaft has shifted, and fuel will not be admitted until the engine has actually stopped and been rotated in the new direction.

Figure 2 is a view of the control stands in the engine room of the *Rand*. It is interesting because it shows contrast between mechanical and pneumatic control. The control stand in the center incorporates the pneumatic control for both engines. It has a selector valve capable of enabling the engine room to take control or transfer it to the pilot house. The stand embodies all of the functions provided in the pilot house "Controlairs."

No pictures were taken of the controls on the engines because of camera limitations, but illustrations will be referred to later on another installation which will illustrate the principle involved.

Figure 3 shows the control stand in the pilot house of the Ashland Oil & Refining Company's M/V *Tri-State*. Here, the Radar is located to the left of the control stand, its front face being just visible. The engine controls are close together.

* *Industrial & Marine Engineer, Westinghouse Air Brake Company.*

Fig. 1

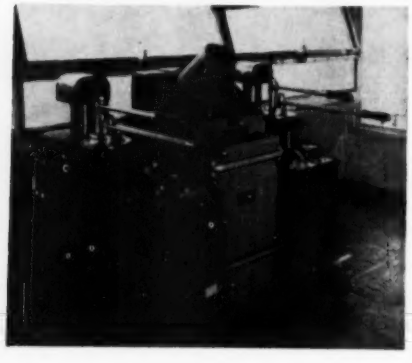


Fig. 2

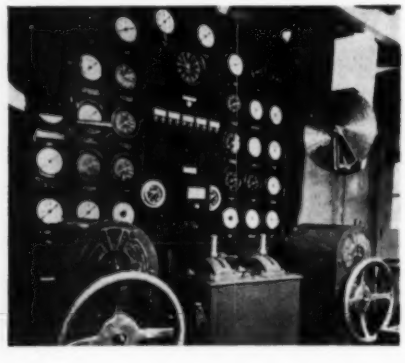
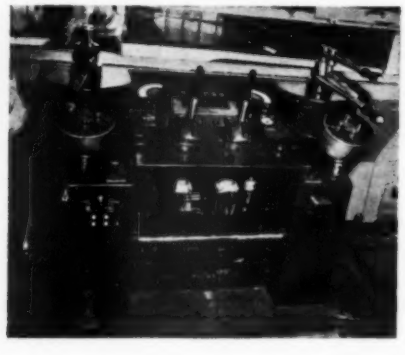


Fig. 3



"Wade Childress" of the Mississippi Valley Barge Line Company during her acceptance tests.

Figure 4 illustrates the simplicity of the control stand in the engine room.

Figure 5 is the front end of the port engine. The valves added to provide the interlocking function for the engine, and incidentally comparable to the *Frank C. Rand* mentioned above, are located on a bracket at the top of the photograph. The end of the "Pneudyne," used for control of engine speed can be observed through the hole cut in the end plate of the engine.

Figure 6 illustrates a technique for control of three reversing engines on the M/V *Aztec* operated by the Indian River Lines. In addition, the steering levers are associated with pneumatic control for hydraulically powered rudders.

Fairbanks Morse "O.P." engines are used on this vessel. A view of the air controls associated with one of these engines is shown in Figure 7.

Where non-reversing engines are used with reversing gears such as the Falk type, a different technique is followed. A good example is offered by Figure 8, illustrating the controls in the pilot house of the M/V *Neville* operated by the Union Barge Line Corporation.

This installation involved General Motors engines. Here, engine control levers move through a "Z" slot quadrant. Neutral position is at the center, the clutch positions being at the sides, and the speed zones being forward and aft of these positions on the control.

Comparable controls are provided in a control stand in the engine room, as done for the reversing engines.

Provision is made that the engine speed can not be increased until a clutch is engaged. However, as a clutch is engaging, the engine power is automatically increased a slight amount. In reversing, it is not possible to apply the second clutch until the first has released. The same relationship of power boost and speed interlocking as explained above for the initial engagement is active during the reversal.

Where diesel electric propulsion is involved, the same "Z" slotted controls have been found most attractive. With this type of propulsion, however, the quadrants normally representing the forward and reverse speed zones are divided to apportion a part to electrical change and part to control of engine speed. This relationship is further maintained at the engine so that if a full speed reversal should have to be made, the engine will slow down, the electrical reversal will be completed, then the electrical intensity will be increased before the engine is accelerated.

An interesting innovation in drive has been used by the Cooper Bessemer Company in a "Dynamatic" or "Gehres" drive. From a control of view, the technique is more similar to the reversing clutch principle than the reversing engine.

An article on controls would not be complete without reference to other builders of reversing engines, such as Atlas, Cooper Bessemer and Enterprise, who have participated in the use of pneumatic controls.

Many operators and boat builders are also involved in the whole picture. However, it is the intent of this article to cover principle rather than detail. Acknowledgement, however, is given for the illustrations made possible through the Dravo Corporation, the Ashland Oil and Refining Company and the Sturgeon Bay Ship-Building and Dry Dock Company.

The great advances in the Inland Fleet have been brought about by the coordination of many interests. Railroads, trucks, buses and airplanes have had their centralized control,—now boats have it.

Fig. 8

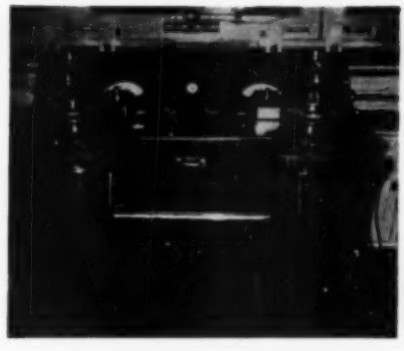


Fig. 4

Fig. 6

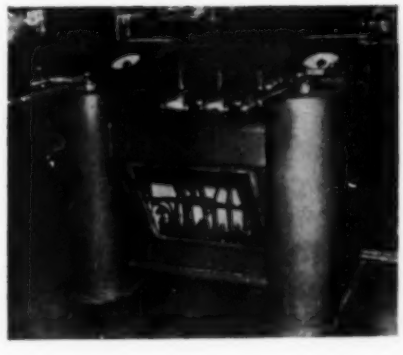


Fig. 7

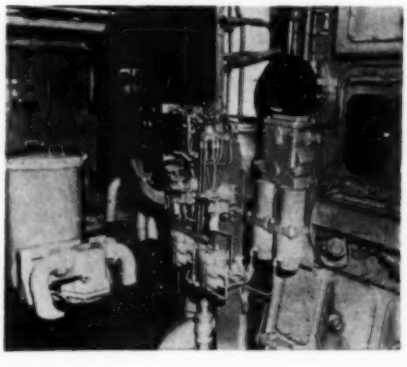
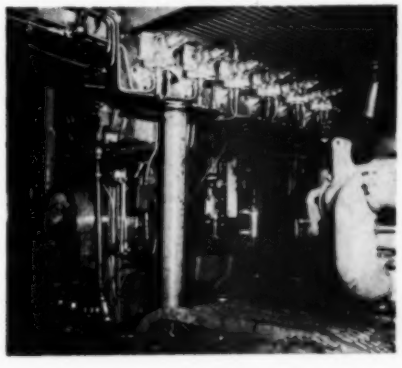
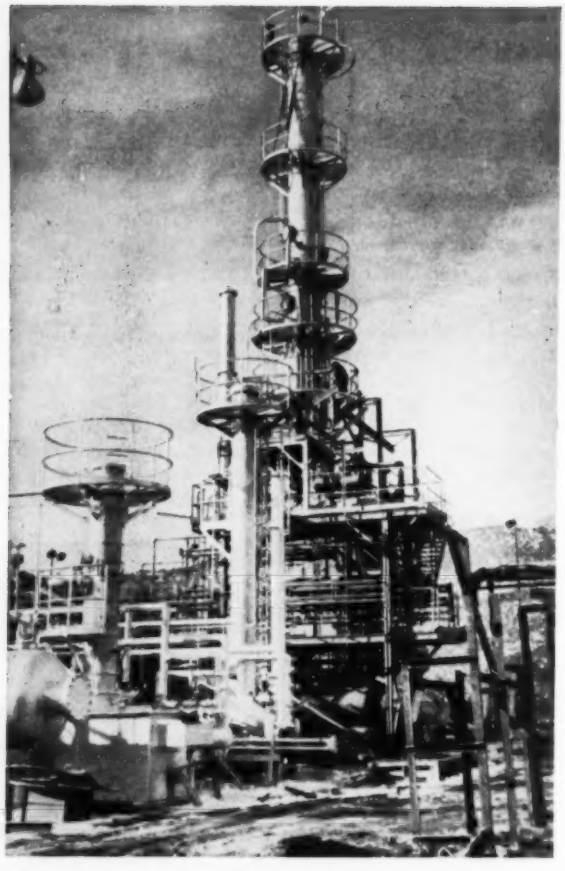


Fig. 5





Shale oil refinery vessels at U. S. Bureau of Mines demonstration plant. Rifle, Colorado.

DIESEL FUEL FROM OIL SHALE

Editor's Note: The description in this article of the experimental refinery at Rifle, Colorado is based on a story in the June issue of World Petroleum by H. Boyd Morris, Chemical Engineer, Bureau of Mines Oil-Shale Demonstration Plant and D. L. Gilbertson, Process Engineer, The Refinery Engineering Company.

AT the 1949 semi-annual meeting of the A.S.M.E. in San Francisco, W. C. Schroeder, chief of the Office of Synthetic Liquid Fuels, U. S. Bureau of Mines, stated that the most of producing synthetic liquid fuels has dropped to the point where refined products such as gasoline, diesel and heating oils can be made from coal and oil-shale for as little as 8.4 to 12 cents a gallon. The cost of oil from shale, excluding interest on investment and profit, is approprximately $2.00 per barrel. Mr. Schroeder stated, and he estimated that with an initial plant investment of $4,000 to $5,000 per barrel per day capacity, a consequent cost of about 8.4 cents per gallon for the liquid fuels derived from this crude oil would be obtained. The figures for liquid fuels from coal are somewhat higher—9 to 12 cents per gallon with a plant investment of between $7,000 and $8,500 for each barrel of capacity per day for plants of 10,000 barrels capacity and over.

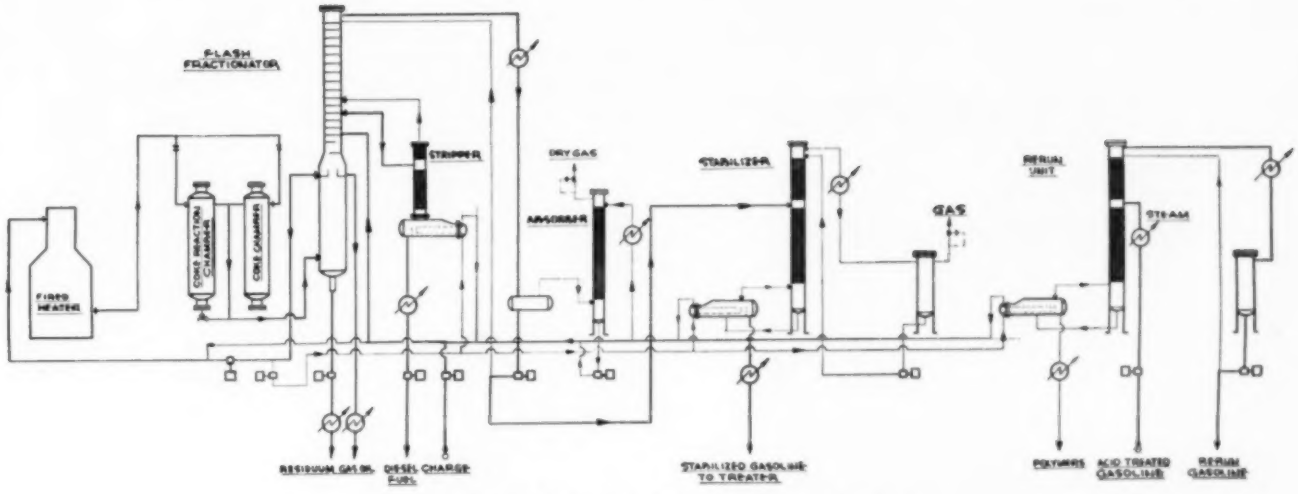
To discuss the former of the two sources of fuels, it should be noted, as pointed out by Mr. Schroeder, that developments in the mining and processing of oil-shale have been largely responsible for the low production cost of refined oil-shale products. Mechanized mining has so increased the output per man that mining costs will be substantially less than 60 cents per ton of shale. There has also been considerabl progress in oil-shale refining and it would seem that 75 to 85 percent of crude shale oil can be economically converted into diesel fuel, heating oil and gasoline.

During World War II it came to be realized with an unpleasant shock, that perhaps our sources of crude oil were exhaustible in the much nearer future than had been thought. Shortages have been overtaken by increased production for the time being but, Mr. Schroeder reiterated, "It does not follow, however, that domestic surpluses will be of long duration in the face of increasing consumption per capita and an increasing population." It should also be remembered that another international emergency could once again make an enormous drain on supplies—one which might make a large supply of synthetic fuels an absolute and indispensable necessity.

It is therefore gratifying to know that these facts are not being lost sight of and that great progress has and continues to be made in the production of liquid fuels from other sources than straight crude oil and that in particular, the vast supply of oil-shale long considered as being an uneconomical source for the recovery of oil, is now becoming competitive due to the technical ingenuity of our experts in devising cheap ways and means of mining and refining.

The latest step in this study is being conducted by the Bureau of Mines of the United States Department of Interior and an experimental refinery has been completed at Rifle, Colorado, the first continuous unit for refining oil-shale to be constructed in the United States. Construction was in charge of the Refinery Engineering Company which contracted for the design, fabrication and erection. The work was carried out through the joint efforts of Bureau of Mines engineers and the Refinery Engineering Company

The oil-shale demonstration plant was dedicated by the Bureau of Mines on May 17, 1947, at Rifle. Being in a remote and mountainous region, enormous expenditure of effort had been necessary to make the operation feasible; roads had been built and utilities brought in and a 50-unit housing center plus the plant structures had been completed. Mining operations and laboratory research had begun, retorting and other facilities completed. In order to have basic data that would reveal chemical operating characteristics and costs of processing on a commercial scale, the



Flow diagram—experimental shale oil refinery. Note production of diesel fuel.

plant was designed to be the minimum size that would operate on a plant scale without producing the inconveniences and untrue figures that are inherent in small experimental installations.

In addition to the careful selection of plant capacity, attention was given to making the design of such a nature to permit various types of operation to be made on the same equipment with only minor changes necessary when changing.

A number of oil companies are cooperating with the Bureau of Mines at the Rifle experimental plant operations.

This installation completes the initial stage of the Bureau of Mines' construction program for their oil shale demonstration refining plant. Data obtained will certainly answer many technical problems and new processes should be evolved.

The operation of this plant brings the production of diesel and other liquid fuels at economic levels a step nearer and is another assurance that the United States will not experience a crippling shortage of such fuels through the rapidly increasing demand or another international emergency.

Oil-shale demonstration plant near Rifle, Colorado. Shale processing equipment is at upper right. The refinery is located among the storage tanks near the center of the photograph. Buildings at the left house various plant auxiliaries and administrative offices. Photographs with this article are supplied by the U. S. Bureau of Mines.

TUNA CLIPPER

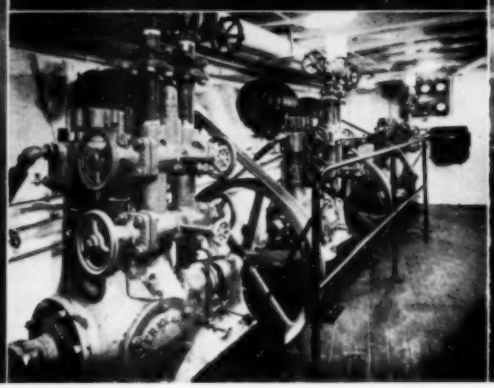
Mermaid

By CHARLES F. A. MANN

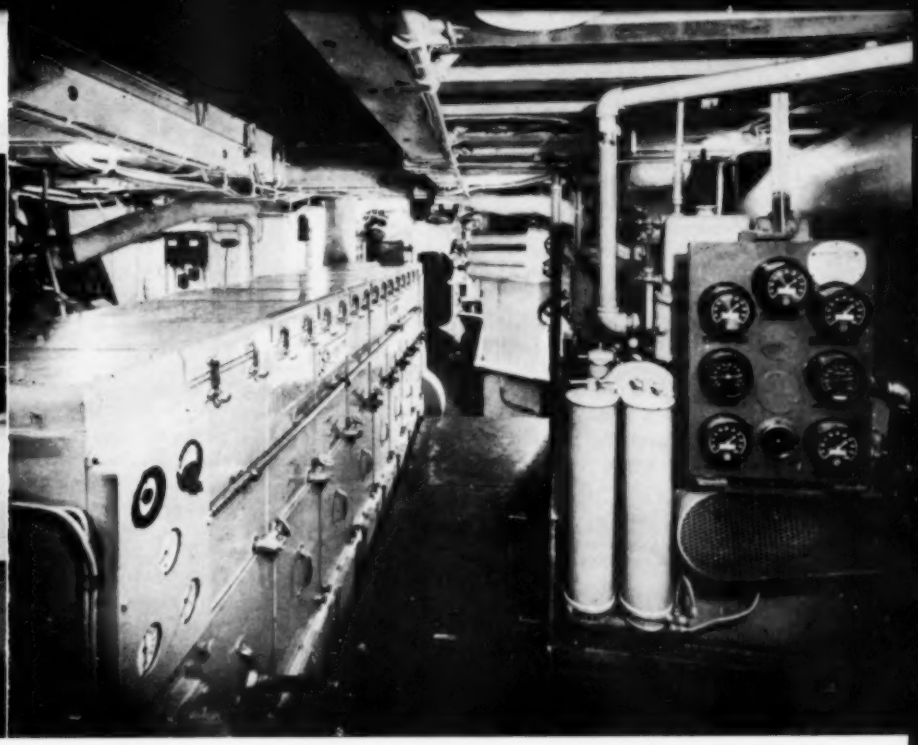
Left: Naval Architect Arthur DeFever and George Peterson, President of Peterson Boatbuilding Company, Tacoma at "Mermaid" trials.

Right: Shaft alley and pump room.

Below: "Mermaid" on trial run.



Top: Pilot house showing engine control stand.
Bottom: View of Baker ice machine.



General view of engine room. Main Superior diesel to the left and Superior auxiliary diesels to the right.

THREE years ago West Coast prognosticators assured one and all that the vast Marine Diesel market of the Pacific would be practically non-existent by 1948 and by 1949 bats would be roosting in the rafters of the busy Boatyards on Puget Sound, incubator of the biggest fleet of diesel powered commercial craft in all the world.

Actually, the tuna and salmon markets bogged down last fall and everybody got scared. Fishing stopped as high priced canned product backed up through the broker-wholesale-cannery-raw fish buyer channels and fishing stopped for a while while prices and the fishermen got back in line. The summer of 1949 finds a lusty stream of new craft from Tacoma's boatyards in the water and headed South to operate out of San Pedro and San Diego, as far south as the northern end of South America.

Peterson Boatbuilding Co. and Naval Architect Arthur DeFever teamed up again this year to construct the *Mermaid*, neat 107 foot Tuna Clipper again embodying more new ideas and refinements in the "Baby Clipper" school of vessel design. The "Baby Clipper" and the "Giant" sizes continue to hold their proponents, each with well-conceived zeal and enthusiasm for the special merits of each type.

"*Mermaid*," built for the usual Southern California Syndicate ownership, headed by Capt. Frank Correia of San Diego, is 107 x 26 x 13 ft. (molded depth), and packs 200 tons of frozen fish in 10 deck wells and 3 bait tanks, along with a crew of thirteen men.

Heavily constructed of Douglas Fir, Fir Plywood and Mahogany trim the ship carries a beautifully designed engine room-shaft alley and pump room area, and a pilot house with a glorified "dash-board" borrowed from the country's fanciest autos.

The power plant consists of a main diesel developing 600 hp. at 450 rpm—an 8 cylinder 12 x 15 inch four cycle engine and two 8-cylinder 150 hp. auxiliary diesels to carry the large electric and refrigeration load. A 3 bladed bronze propeller 62 x 44 inch size is fitted. Two 75-kw. alternators are driven by the auxiliaries. A 40-CFM auxiliary air compressor and pneumatic starting motors are fitted on the auxiliaries. Bait pumps and a battery of 14 small brine circulating pumps are fitted in the shaft alley.

Tank capacities are 33,000 gallons of fuel oil, including dual use steel lined fish wells (4); 2500 gallons of fresh water and 800 gallons of lube oil are carried. Fresh and salt water sanitary systems are carried.

Complete radio and fathometer, automatic pilot; two speedboats and electric deck machinery are additional items of equipment carried. Three 5½ inch ice machines are carried on the machinery flat to handle the heavy refrigeration load.

We have, from time to time, described new fishing vessels of this type in our pages, but the "Mermaid" is certainly second to none in her trim lines and carefully conceived design and layout.

Latest to join the huge tuna fleet, "Mermaid" profits from the wide experience of her builders and operators. The refinements incorporated resulting from this experience plus a number of new ideas will certainly make her easy to operate and give her a head start on the tuna fishing grounds.

As an outstanding example of the "Baby Clipper" type of vessel, "Mermaid" will certainly cause much head-scratching among the "Giant" proponents in a search for further arguments to justify their own well supported school of thought.

The Peterson-DeFever team is certain to receive many congratulations on what is not only a practical boat but one of the most graceful to operate from the West Coast.

Photographs by Richards Studio, Tacoma, Washington.

EQUIPMENT.

Main engine—The National Supply Company, One 600-hp Superior Diesel.

Auxiliary engines—The National Supply Company,

Two 150-hp Superior diesels.

Alternators—Electric Machinery Mfg. Company, Two 75 kw.

Auxiliary air compressor and pneumatic starting motors—Gardner-Denver Company.

Ice Machines—Baker Ice Machine Company. Bait and brine circulating pumps—Fairbanks-Morse.

COMPOUND POWER PLANTS

By P. H. SCHWEITZER AND J. K. SALISBURY

PART II

Editor's Note: This article, the second part of which is published below, consists of excerpts from the paper given before the S.A.E. summer meeting at French Lick, Indiana. Dr. Schweitzer is professor of engineering research at Pennsylvania State College and Mr. Salisbury is division engineer at the Thermal Power Systems Division of General Electric Company.

3. Experimental Investigation of the Compound Engine

The results of an engineering investigation of the compound engine carried out at the Engineering Experiment Station of The Pennsylvania State College have not heretofore been reported in the technical literature. As representatives of the two agencies concerned with this work, the authors presented a few of the results of this experimental investigation.

The experimental work was conducted to ascertain the feasibility of operation of an essentially standard engine at high supercharging pressures, to determine engine power at these pressures, to explore the heating problems which might arise, to study air-flow characteristics of the engine under these conditions, and to determine the effect of "short-circuit" air. Another objective was to determine whether there were any detrimental effects due to operation of the engine at high mean effective pressures, when the maximum pressure of the engine is limited to its normal value.

A commercial engine having 16:1 compression ratio was modified for these tests. The modifications consisted chiefly of insertion of a spacer plate between the head and block of the engine, to reduce its compression ratio to 5.19:1, modification of the injectors (and push rods) to increase their fuel pumping capacity to approximately twice the original design value, and minor improvements in the lubrication system. As shown in Fig 16, the functions of a reciprocating hot-gas generator were synthesized by use of external air compressors supplying compressed air to the engine, the power of which was measured by a dynamometer. By equating the engine power output to the calculated input to the air compressors all pertinent thermodynamic effects were determinable. An exhaust gas regenerator was used for heating of the compressed air (normally supplied at lower than compression temperatures). An additional electrical heater was provided for control purposes. Necessary instrumentation included standard flow nozzles, temperature measuring devices, and arrangements for fuel measurement. The engine exhausted into a surge tank, as shown in Fig. 16, so that no attempt was made to recover the "puff energy" of the engine. Since puff energy recovery represents an appreciable portion of the power available in the turbine exhaust, the thermal efficiencies and turbine power would have been considerably augmented, had puff energy been considered.

Before modification of the engine was undertaken, tests were made to determine the standard engine characteristics, including power output and thermal efficiency. After modification of the engine, a series of tests was made at various supercharging pressures, with the engine power adjusted for each test to equal the calculated compressor input power. Results of the tests are given in Fig. 17. As a result of this experimental investigation, it was concluded that it is feasible to operate the diesel engine as a hot-gas generator at high supercharging pressures. The engine output balances the compressor input at pressure ratios of approximately 6 or 7:1, with peak engine pressures equal to those of current diesel-engine practice. It was also concluded that a reciprocating hot-gas generator-gas turbine thermal power plant can be built which will be competitive with the conventional simple cycle gas turbine in both size and weight, and which will excel the latter in fuel consumption, with comparable investment of engineering effort, and development facilities.

4. What Kind of Compound Power Plant?

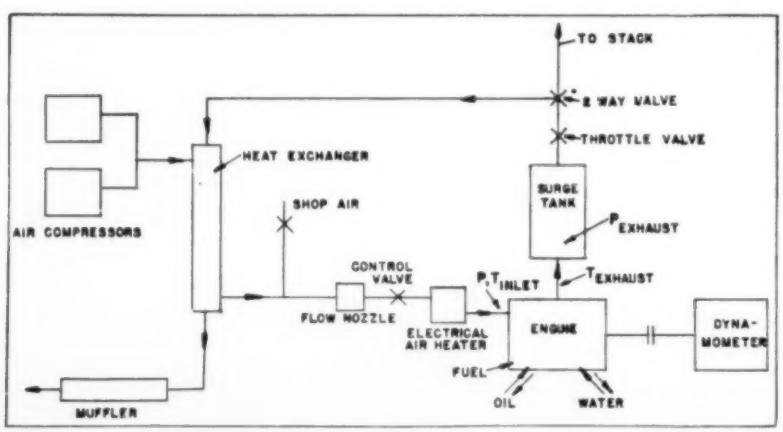
Because the number of possible arrangements of compound power plant is tremendous, only three promising types are selected for brief description. Best fuel economy can probably be obtained by the free piston or the semi-free piston hot-gas generator (sometimes called the controlled-piston type) operating at approximately 6 to 7 atmospheres supercharge, under the balanced cycle.

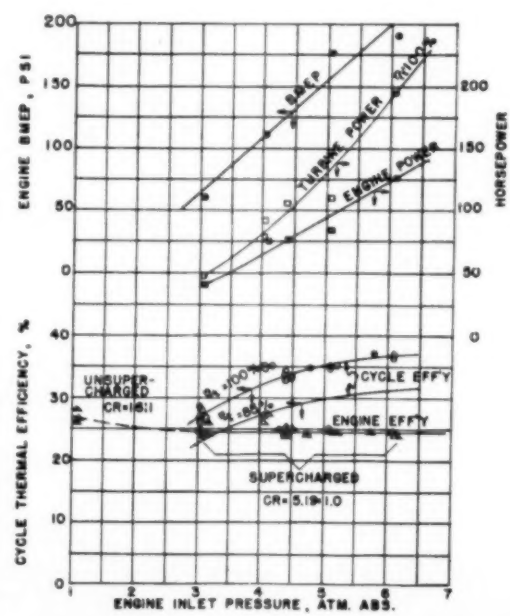
Semi-Free Piston Unit

The schematic arrangement of the true free-piston type was shown in Fig. 8. One elementary version of the semi-free piston type is sketched schematically in Fig. 18. This arrangement resembles two opposed free-piston units arranged in tandem, but with the piston motion kinematically determined by a single crankshaft and a pair of connecting rods and crossheads serving both cylinders. The design of the cylinders is similar to that of the free-piston unit but the "bounce" is insufficient center. Bounce is supplied by the compressor cylinder because the discharge valves, 5, are at a distance from the end of the cylinder. The deficit in the bounce may be supplied by a light flywheel or by the crankshaft alone. The crank mechanism neither transmits useful power, nor does it make the rotation uniform. Its principal duty is to sup-

Fig. 17—Summary of Test Results.

Fig. 16—Arrangement of Test Equipment.





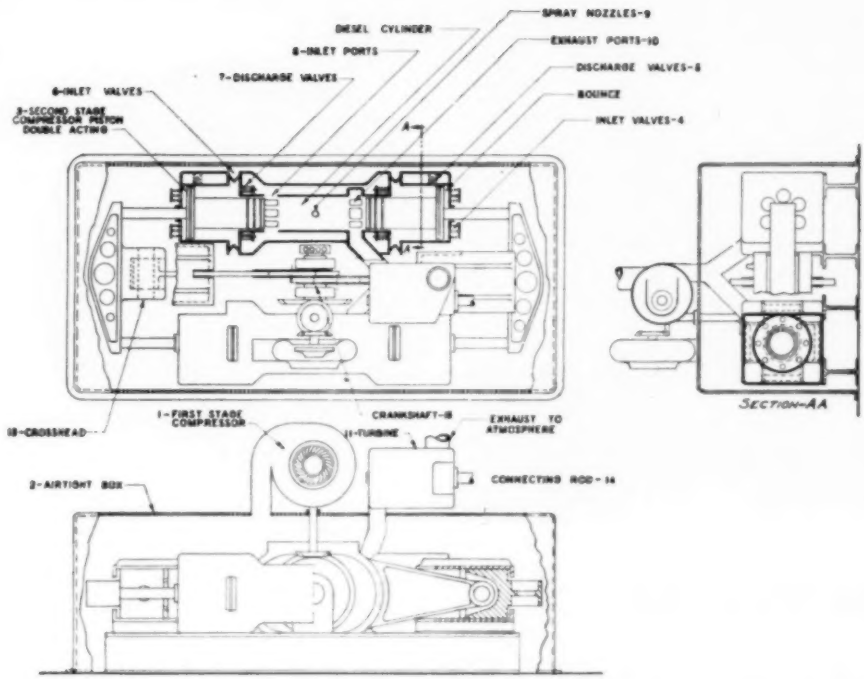


Fig. 18—Semi-Free Piston Hot-Gas Generator.

plement the bounce, to help the piston over dead center, and to synchronize the two pistons, which are some 10 degrees out of phase with each other. The connecting rods and crankshaft can therefore be light: little heavier than the synchronizing linkage of the conventional free-piston unit.

The semi-free piston hot-gas generator has the following advantages in common with the conventional free-piston machine.

1. No side thrust, giving low friction and wear.
2. No long ducts between compressor and engine to cause pressure and heat losses.
3. More favorable velocity-stroke diagram than the sinusoidal curve produced by uniform crank rotation.
4. Small space requirement.

The semi-free piston arrangement has the following advantages over the conventional free-piston unit:

1. It permits non-symmetrical port timing through a slight phase difference between the piston motions. This is achieved by placing the eccentrics 170 degrees apart, giving a 20 degree exhaust lead in port opening if the exhaust and inlet ports close simultaneously. This will increase engine power.

2. Fixed piston stroke and compression ratio with no uncertainty in inner and outer end points of piston travel.

3. Freedom in design from any restraint imposed by the necessity of selecting a bounce volume just large enough to produce self-ignition on the inward stroke and not large enough to produce excessive compression pressures.

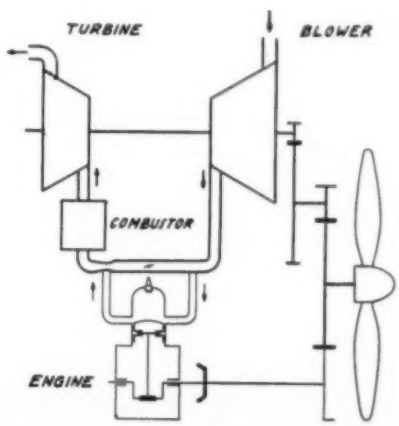
4. Better speed control.

5. Injection pump, water pump, lube-oil pump, and other accessories driven by a rotating shaft, rather than an oscillating shaft or separate motors.

6. Simpler starting. Conventional free-piston machines must fire at the first stroke. They cannot be cranked, whereas the semi-free piston machine can be cranked and started by standard means.

The disadvantages of the semi-free piston machine are chiefly the unbalance due to the small phase difference between the pistons used to obtain unsymmetrical scavenging, and the necessity for the crank and crosshead mechanism. These parts can be light, however, because they transmit little power; are accessible, cool, and easy to lubricate.

Fig. 19—Turbine Compound with Two-Stroke Cycle Ignition Engine.



The difference between the free-piston and semi-free piston machine is more a matter of convenience than of principal nature; a matter of mechanical design rather than thermodynamics. Substantially the same specific fuel consumption should be attained. At a supercharge ratio of seven, the sea-level fuel consumption would be around 0.41 per bhp-hr with a steady flow turbine (see Fig. 12), and around 0.37 lb with partial blowdown recovery which appears to be practically feasible and certainly highly desirable. At altitude the fuel economy is still better.

A tandem machine, such as that shown in Fig. 18, with 8 in. bore and 12 + 12 in. stroke should deliver a little more than 3500 bhp. It can be contained in a space 10 ft. long, 6½ ft. wide, and 3¾ ft. high, with turbine, blower, and controls requiring a reasonably small adjacent space. This net power output corresponds to 490 psi bmep, or at 1200 rpm to 1.485 bhp per cubic inch displacement.

Geared Unit With Moderate Supercharge

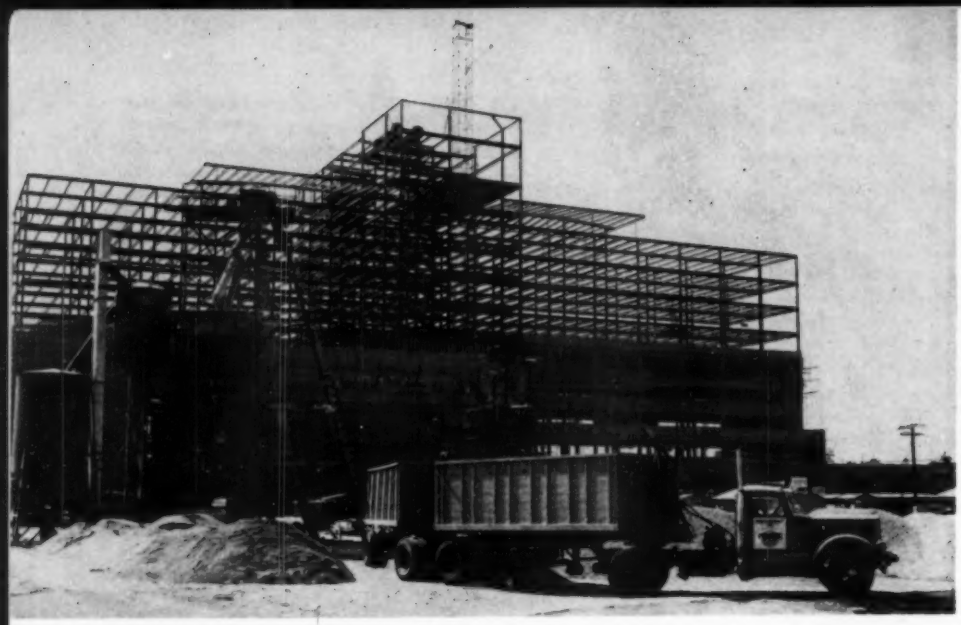
The next poorer plant in expected thermal efficiency is the two-stroke cycle diesel engine, with geared turbine and blower, operating with two to three atmospheres supercharge. Spark ignition engines with this arrangement are being developed by American aircraft engine manufacturers. Weight and specific fuel consumption probably could be reduced by using the smaller and more efficient two-stroke cycle diesel.

An alternative version of this arrangement dispenses with the mechanical connection between engine and turbine-blower, so that all of the turbine power is absorbed by the supercharger. This arrangement is simpler and, according to one study, only slightly less efficient than the geared arrangement. Estimates of fuel consumption are 0.4 and 0.42 lb per bhp-hr for the all-geared and the floating turbocharger, respectively. The net specific power output would be approximately 1.2 hp per cubic inch of cylinder displacement.

The Parallel Engine Arrangement

In the compound power plants described so far a turbine has been attached to an engine. The process can be reversed by starting from a turboprop power plant and attaching an engine to it. The emphasis is left on the turbine, thus minimizing engine development.

In Fig. 19 the heavy lines show a schematic diagram of a conventional turboprop power plant geared to a propeller. The turbine has a conventional combustor where the fuel is burned with the customary 300-400 percent excess air, to keep the final gas temperature below the permissible limit. Light lines on the figure show an engine also geared to the propeller and arranged in parallel with the air line between blower and combustor. The two-stroke cycle loop-scavenged spark-ignition engine, supercharged by air from the blower, exhausts into a venturi at the entrance to the combustion chamber. Part of the total fuel supply is burned in the stationary combustor, and part of it is burned in the engine, thus producing part of the power at higher efficiency than in the simple gas turbine.



Prudential Building, Los Angeles, under construction. Diesel-engined truck and diesel-engined skip loader can be seen.

Diesel bulldozer pushing pummice into hopper of feeder belt to supply mill operations.

DIESELS IN PROCESSING OF PUMICE CONSTRUCTION AGGREGATE

By FRED M. BURT

THE most outstanding examples of major weight and cost savings achieved by the use of light weight pumice aggregate, are represented in the construction of the General Petroleum and the Prudential Life Insurance Company's new buildings in Los Angeles. From mining, milling and on to construction, the use of diesel power is heavily predominant.

In the General Petroleum Building, the largest office building in Southern California, the dead load of structure was reduced 8300 tons in the light weight concrete work, with structural steel weight requirements reduced by 1200 tons, to the tune of a $180,000 cost saving. Located near the La Brea tar pits, the Prudential building design presented a serious structural problem as the subsoil would not properly support a great weight. This problem was solved by special designing plus the use of the pumice aggregate.

Crownite certified pumice supplied by Desert Materials Corporation, Los Angeles, was used in both of these buildings; also in many other Southern California structures including numerous naval installations, in a pontoon bridge between Long Beach and Terminal Island, in department stores, factory and other office buildings and numerous home building projects.

In Inyo County on the floor of Rose Valley, circled by the Coso Range foothills, the Desert Materials Corporation controls the greatest area of the purest pumice deposits as yet found in the United States. W. B. Stromer, Superintendent of mining and mill operations estimates that at least 5,000,000 cubic yards of pumice have been blocked out, though this may prove to be but a relatively small percentage of the quantities available.

Mill operations are centered on a 36 acre tract at Coso Junction where two highways meet and on a siding of the Southern Pacific railroad, to give both truck and railway transportation to markets in Southern California, the San Joaquin Valley and the San Francisco Bay region. Mining operations are carried on about eight miles from the mill. All mining is from open pits. The first operation is the scalping of the overburden, using diesel engine equipment; as much as 100,000 yards of overburden has been removed in 45 days.

After scalping of the overburden, mining is carried on with a dragline equipped with a 2½ yard bucket. This unit fills three diesel trucks. With an average daily haul of 900 cubic yards, huge stock piles at the mill are kept well built up. At the mill the truck loads are dumped on a large scalping sieve made of railroad iron to prevent any material over 5" diameter from clogging gates under the mine-run stockpiles.

In mill operations, turning out up to 1400 cu. yds. daily a diesel tractor with bulldozer forms the stockpiles and feeds the mill hopper. The principal mill equipment consists of a diesel generator, 104-KVA, 440 volts; 10 motors consisting of 7—5-hp, 1—7½-hp, 1—10-hp, and 1—50-hp; 2—3KW transformers, cutting to 110 volts for lights; 1—3 deck screen, 4' x 10'; 1—2 deck screen 4' x 8'; 1—roll crusher, 18" x 30", and 7 conveyors.

Mine run pumice pushed into the first hopper is carried on to a feeder belt to the main conveyor belt and then through screening and roll-crushing operations to grade continuously and automatically into the six grades of Crownite pumice, ranging from the fineness of plaster sand to 1¼" material. A skip loader, powered with a 152½-hp diesel engine, is used to load trucks for line hauls from stockpiles, handling about one cu. yd. per minute. A similar unit was used to feed the batch plant during the construction of the Prudential Building. Deliveries from Coso Junction to the job were made with a fleet of diesel trucks hauling about 43 cu. yds. in two trailers.

New facilities under construction and planned, also to be diesel-engined, will provide bulk-headed stockpiles of different grades of processed pumice aggregate, with a total capacity of about 5,000 cu. yds. These are built up over a 6-foot diameter culvert pipe containing traps and a 30" wide, reversible conveyor belt, to load railroad cars at one end (a 75 cu. yd. car in 30 minutes,) and trucks at the other end in about 15 minutes each. As compared with concrete sand weighing 2500-lbs. per cubic yard, this pumice weighs from 850-lbs. per yard for coarse, to 1150-lbs. for fine ground. According to E. Phil Lockwood, technician for Desert Materials Corp. structural pumice can readily be produced with strengths ranging from 1500 to 3000-psi, and dry weights from 75 to 105 lbs. per cubic foot, weights varying about as the strengths. Non-structural concrete such as roof fills, can be produced with strengths of 500 to 1,000 lbs. per square inch, and weights as low as 65 lbs. per cubic foot.

Equipment includes the following: Caterpillar Tractor, Link-Belt, Le Tourneau, Cummins Engine and Hough.

DIESEL FACTORY

CATERPILLAR Tractor Co., Peoria, Illinois, has dedicated, and geared for full production its new diesel engine factory. With an area of 925,000 sq. ft. contained within its rectangle, the factory represents four and one-half years of planning to convert from the planning boards a plant engineered for a specific operation, rather than a conversion of an operation to a specific type of building.

The building, from its conception, was designed, erected and equipped expressly for the economic manufacture of the Company's line of Diesel Engines. Designated as Building KK in the extension of Caterpillar manufacturing facilities, the structure houses facilities to produce all of the diesel engines, merchandised as industrial power units, marine engines and electric sets, in the company's line.

From the time the big earthmoving rigs bit into the land along the Illinois River and removed and filled some 202,500 cu. yds. of dirt for the original foundation site, the company built the building around the design so that machining, testing, shipping and other related engine work has been accomplished under one roof. The factory measures 1,120 ft. long in an east-west direction and 757 ft. in north-south width. Its subsequent value is recorded in the time and labor saved by proximity of adequate casting storage yard, adequate rough storage area inside the building, numerous conveyors to move rough material from storage to the machine lines, proper width of aisles, an efficient industrial railroad layout and the movement of material through an open inspection area. Its suitable space for storage of finished parts, the efficient application of bridge cranes, fork trucks and other related material control factors has given a flexible and efficient movement of materials and the last word in modern mass production.

A fitting example of ingenuity and engineering is the fact that one man on the engine assembly line may work on 19 different engine models moving on a conveyor line.

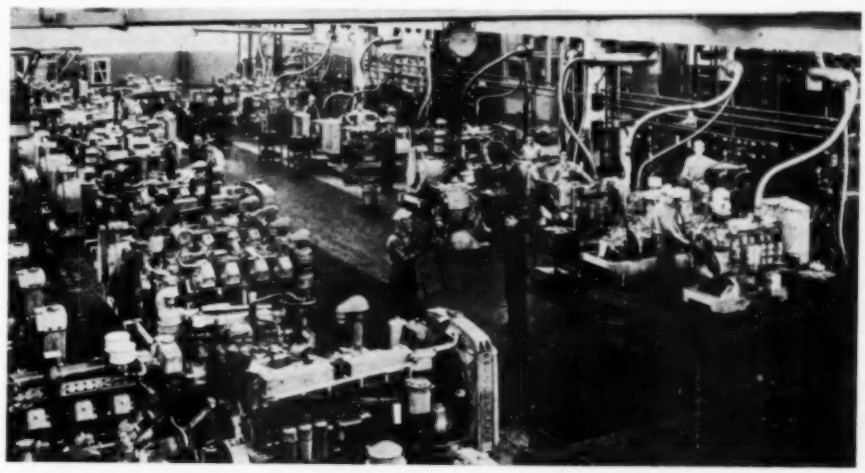
The assembly area consists of three assembly lines for basic engines, two for erection, testing, painting and shipping of industrial engines, a test room and large areas for the storage of finished parts, both purchased finished and machine shop finished. All three basic engine assembly lines, running parallel, end in the same bay, where a bridge crane is used to remove the engines to a set of gravity roller conveyors along which they are moved by a drag chain into the test room and stored pending test.

The test room, adequately lighted, ventilated and elaborately sound-proofed, is arranged in two banks of test cells, each bank serviced by a bridge crane to install engines from the conveyors and to remove them to the out-going conveyor to one of the two adjustment floors. There fixtures and gantry cranes have been provided to expedite necessary tear-down and adjustment work. The 21-celled areas has the capacity to test two engines at a time in each cell. Its design provides the space and type of construction which promotes cleanliness, safety and efficiency. Engine exhaust in this new test room is dissipated through mufflers extending through the roof. All other service connections necessary when installing the engine on the test block are made to lines brought up through the floor from a basement extending under the entire test room.

Of the 925,000 sq. ft. floor area some 425,000 sq. ft. is devoted to machine shop. All of the area is on one floor with the exception of 156,000 sq. ft. on a T-shaped mezzanine above the main floor and 25,000 sq. ft. in a basement under the test cells. Showers, cafeterias and some offices are centrally located on the mezzanine and do not conflict or congest operations in the working area. The two cafeterias, strategically and conveniently located east and west, comprise 15,834 sq. ft. and are equipped to serve the 3,322 employees.

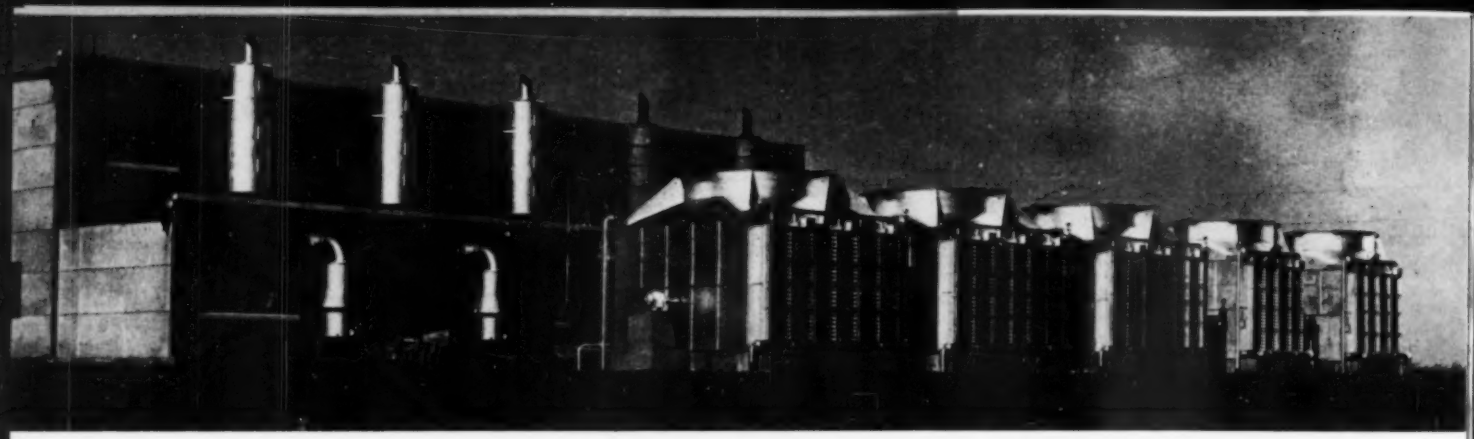
An air system is provided comprised of several units mounted on the roof at strategic locations, so distributed and of sufficient capacity to completely filter, heat and recirculate all the air in the building in a little less than eleven minutes. The heat is supplied through a tunnel to these pent houses from the enlarged central heating plant. The building is provided with a fluorescent lighting system to give 40 foot-candles of illumination at eye level. Power is distributed throughout the building to the machines by means of a tailor-made buss-duct system.

Outside the building a waste emulsion disposal plant, bordering the Illinois River, is used primarily for the prevention of pollution. A question to which Caterpillar gave extensive consideration.



Test area for industrial engines. Generator sets and other special attachments are tested here.

Airview of building KK, Caterpillar Tractor Company, Peoria, Illinois.



General view showing rear of plant with cooling units and exhaust silencers.

PROGRESSIVE IOWA COOPERATIVE

By DWIGHT ROBISON

AMONG the many REA power plants, that of Creston, Iowa is outstanding. Completely modern and serving a fourteen county area, it is a good example of careful planning brought to a successful conclusion. The architecture, severely utilitarian, is nevertheless pleasing and not a scar on the Iowa countryside.

Conceived in 1940 Greenfield Farmers Electric delegated a representative to Washington to investigate the possibility of building a central power plant for REA cooperatives, after articles of incorporation were drawn up in 1941, plans had to be shelved just as a further delegation was in Washington to discuss financing when fateful December 7, 1941 brought war to the United States.

However, optimistic planning continued and in July 1944 application was made to REA for a loan of $800,000. By 1946, five distribution cooperatives were participating in the group project and a plant site was established in a central location north of Creston. In May 1946 the first contract for two 1,100 kilowatt diesel generators was let and in September of that year John J. Hyde was appointed manager of the plant. In 1947 the second loan of $1,300,000 was received permitting expansion from 2,200 kilowatts to 5,788 and major contracting and equipment contracts were signed, the ground-breaking ceremony taking place in June 1947. The first electrical energy was transmitted from the new plant November 3, 1948.

The spacious engine room presents an imposing sight with its line of two 1575-hp, 1100-kw, and three 1682-hp, 1196-kw, diesel-generator sets. In keeping with the uncramped layout, the control panel is located opposite the generator sets with plenty of room for operation and meter observation when the engines are running.

Maintenance and ease of servicing was carefully studied when the plans were being drawn up and the engine room is equipped with an electric travelling crane to facilitate removal of heavy engine parts.

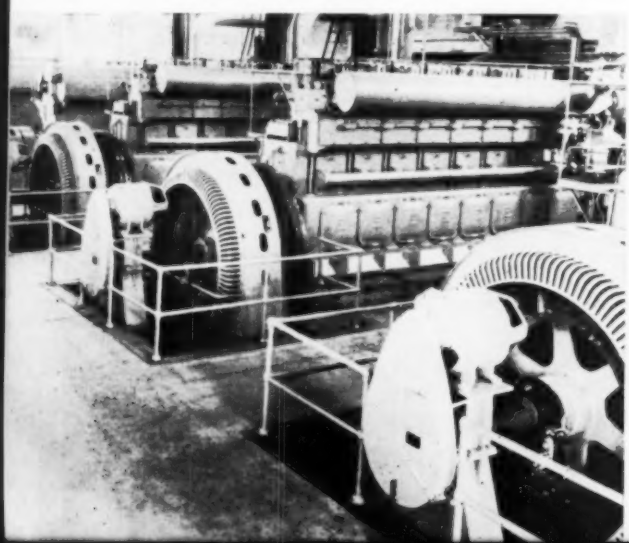
The outside of the plant is dominated by the imposing bank of five cooling units. These are used for controlling the temperatures of the engine jacket water and the water used for cooling the lubricating oil. With radiator type cooling coils, these vertical air discharge coolers are equipped with automatic, thermostatically controlled, electrically operated shutters.

On the side of the building, behind the cooling units can be seen the exhaust silencers. Three 50,000 gallon fuel tanks and the large power substation for stepping up the current to the transmission lines to 34,500 volts, are landmarks.

Earl E. Whitney is the diesel plant superintendent of this modern installation.

Up to the end of 1948, the five member distribution cooperatives and their power cooperative together had received a total of $15,144,338 in REA loans, possesed 4,175 miles of transmission line and were serving some 9,000 customers. Concrete plans have already been made for further improvements and expansion of facilities.

General engine room view.



John J. Hyde, Manager, Southwestern Federated Power Cooperative Inc., Creston, Iowa.

EQUIPMENT

1—Whiting 5-ton electric travelling crane.
2—Cooper-Bessemer LS-8-TGD diesel-generator sets 1575-hp, 327 rpm, Elliott turbocharged. Generator: Ideal, 1100-kw, .8 PF, 3/60/2400 volts.
3—Enterprise DSQ-318 diesel-generator sets: 1682-hp, 360 rpm, Elliott turbocharged. Generators: Electric Machinery, 1196-kw, .8 PF, 3/60/2400 volts.
5—Young Radiator, vertical air discharge, cooling units.
2—Hilco fuel filters.
5—Hilco lube oil filters.
5—Maxim exhaust silencers.
5—Cycoil Air filters.
6—Pittsburgh fuel meters.
2—Quincy air compressors.

DIESEL REPAIRS WITH METALLIZING

By JOHN E. WAKEFIELD

Diesel locomotive engine piston being metallized.

WITH more and more diesel engines coming into use, repair and maintenance have become major problems. Worn crankshafts can be ground undersize and fitted with undersize bearings, but that usually means large stocks of odd size bearings at strategic spots. Valve stems become sloppy while there is still plenty of stock in the seats. Pistons and liners lose their proper clearances and must be replaced. Oil pump driveshafts wear.

Metallizing has proved to be a practical and economical way of rebuilding many of these parts. The process is fast, for modern guns spray more than 20 pounds of steel an hour. Costs are low, in many cases hardly more than 10% of replacement costs. Metallizing is a cool, dry process, eliminating the danger of distortion or heat stresses in the parts rebuilt.

In addition of these obvious advantages, sprayed metal coatings often wear longer in service than the original parts. Their greater resistance to wear is accounted for by two factors. In the first place, spraying increases the hardness of steels and stainless. There is a chilling effect and an increase in carbon content. Hence, spraying a part with the same type of metal of which it is made, usually gives an even harder surface than before. Secondly, all sprayed metals are porous, and the pores absorb and hold appreciable quantities of oil. All sprayed metals run with less friction than the same metals in ordinary form.

Thus, besides being a fast and economical "putting-on" process, metallizing quite often improves the wearing qualities of the parts built up. This means less frequent repairs, and more continuous trouble-free service.

Crankshafts

Probably the most common metallizing application in diesels is the rebuilding of worn crankshaft throws and mains. Back as far as 1940, the Association of American Railroads reported observations on 30 crankpins and 24 main distributed over 8 crankshafts. These were 10 inch by 12 inch, 300 hp. engines, having a crankpin diameter of 6.375 in. and mains of 6.250 in. The first of this group was metallized in 1936 and was operating entirely satisfactorily after 10,000 hours.

Figure 1 shows an even larger crank being metallized at the Atlas Metal Spray Company in Philadelphia. One throw, 8¾ in. in diameter by 6 in. long was turned ⅛ in. undersize, then metallized with .25 carbon steel. The coating was built up oversize and machined back to standard. Work has been reported on almost all sizes of cranks used in diesel switcher, tractors, trucks, marine and stationery engines. Typical of the smaller work is an example where .80 carbon steel was used. This metal is hard enough so that it has to be ground. For that reason, it wears even longer than the .25 carbon steel mentioned above.

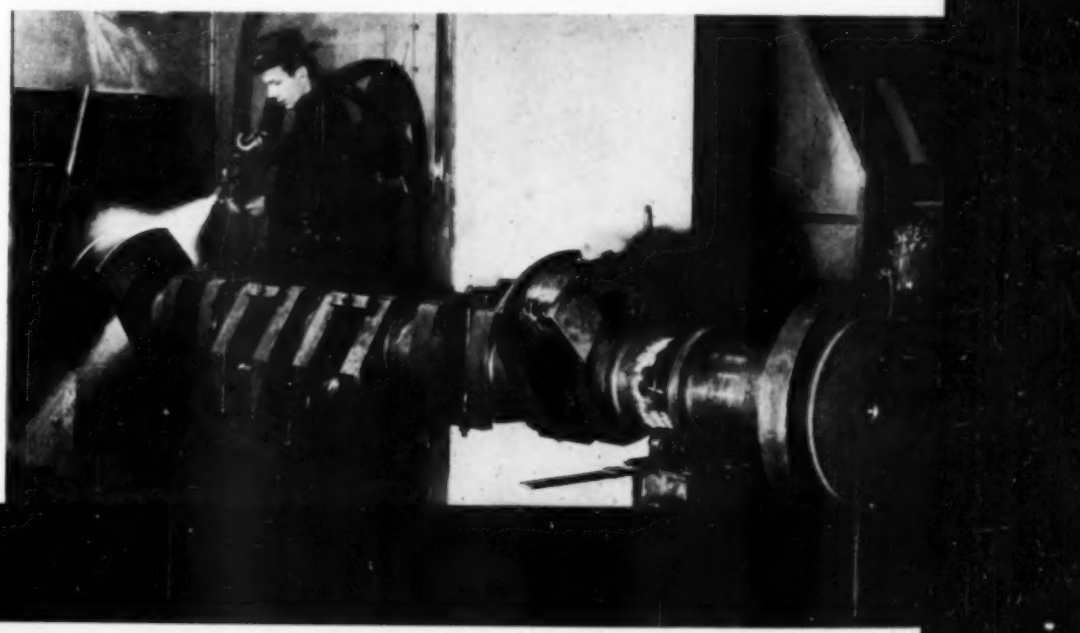
Preparation

Proper preparation of the surface is the most important part of all metallizing work, especially on crankshafts. The first step is to grind or machine the journal undersize. This should be at least ⅛ in. on the diameter, since too thin coatings will not have sufficient strength to withstand the fairly heavy loads. Undercutting also accomplishes the very necessary cleaning of the surface, since it removes enough stock to expose clean, bright metal. This is extremely important, for sprayed metal will not bond to dirty, oily surfaces.

The next step is to roughen the undercut area. There are several good ways to do this. All of them leave hooks and anchors for the sprayed metal particles to key into when they land and flatten out. 95% of the particles are molten when they land, and they need physical anchorage to the base.

The roughening method which produces the strongest bond consists of grooving (or threading) and the use of a special rotary shaft preparing tool. A square-nosed tool is ground .045 in. to .050 in. wide. Corners are stoned off, so that no

Figure 1. Metallizing a large crankshaft.



sharp lines will be left in the base. A 16 thread feed is used, or straight grooves cut with comparable spacing. Then, the special tool is run lightly over the threads several times. Depth of thread, by the way, should be about .020 in., although exact depth is not critical. The special tool for roughening the threads consists of five circular saw-like blades, assembled with teeth staggered to produce a very irregular cut. This roughens the threads and rolls their edges slightly, so that dovetails are left in each thread. Figure 2 shows a small shaft prepared in this way. In spraying over this preparation, the first few passes should be made at right and then left angles of about 45°. This fills the grooves and prevents bridging over. The rest of the build-up is done with the gun at right angles to the work.

A variation of this method which produces nearly as strong a bond is to cut a 24 to 30 V thread and then use the special rotary shaft tool. V threading tools should have the point stoned off slightly, again to prevent leaving sharp lines in the base. While the bond produced by this variation is not quite as strong as the other, V threads are faster to cut, and the method is satisfactory except for the heaviest loads.

On smaller cranks, and hardened ones where the case is deep, it is often impossible to thread or groove. Here, other methods must be used. One is to blast the undercut section with 80 to 100 psi. in a pressure blast machine, using G-16 or G-18 angular steel grit. This method is quite successful, where a thorough blast job is done. It was the earliest method used for preparing all kinds of mechanical parts for metallizing.

Another non-mechanical method which works out well is electrical preparation. A special nickel alloy electrode is brushed lightly over the surface, as shown in Figure 3. Current is supplied by a special generator similar to those used for welding. The electrical resitsance heating of the electrode metal causes it to be simultaneously exploded into a sort of foam, and firmly fused to the base metal. The result is a great many irregularly shaped cavities that make a good bond for the sprayed particles. Penetration of the electrode in the method is no more than .005 in., so the heat of fusion is confined to the outer surface. This method has been used successfully on many types of cranks. The important thing is to be sure that at least 95% of the surface is covered with electrode deposit. Failures have occurred where not enough area had been prepared.

There is one other, newer method which appears suitable for cranks, but it has not been used to any great extent as yet. An alloy high in molybdenum can be sprayed with an ordinary metallizing gun and will bond itself firmly to smooth even highly polished metal surfaces provided they are perfectly clean. Once applied, it makes an excellent bond for all other sprayed metals.

On very hard crankshafts, the electrode deposit or the self-bonding undercoat are the only methods that will insure a good bond. The electrode method was developed originally just for hardened surfaces of a similar nature.

Before leaving preparation, which incidentally applies to almost any mechanical work with metallizing, it should be noted that threading should be done wherever possible. Blasting, the electrical method and the self-bonding undercoat all give better anchorage when done over threads. Furthermore, sprayed coatings themselves are stronger if they are given the irregular or upset laminations that occur over threads, than if they are sprayed on relatively smooth surfaces. As a rough comparison, think of the toughness of gnarled wood compared to straight grained wood.

Selection of Metal

Diesel crankshafts are always built up with some type of steel, of course. However, there are two factors in the selection of a particular steel. One is finishing facilities available. If grinding equipment is not on hand, a soft steel such as .10 or .25 carbon steel must be used. Both can be machined quite readily, although better finishes will be obtained with cemented carbide tools. Naturally, they will not wear, that is the soft steel won't, as well as the harder metals. The other factor is the shrink characteristics of the various steels. The lower the carbon content, the greater the tendency to shrink. That is another reason why .10 and .25 carbon steels are not so desirable. It happens that both have high shrink, and can crack if applied with excessive heat; .80 carbon steel and medium-chrome, medium-carbon stainless steel are the most favorable for crankshafts. Both are hard and must be ground. They wear extremely well. Both have low shrink characteristics, and therefore, can be built up to any desired thickness.

Bearing Metals

All sprayed metals seem to operate very satisfactorily in babbitt bearings at ordinary clearances. However, with some types of bearings, the newer harder types, some extra precautions should be taken to set up the bearings with a little extra clearance. In copper lead bearings, for example, it is a good practice to allow .002 in. to .004 in. extra clearance. Where this is done, sprayed crankshafts operate for very long periods without trouble in this type of bearing.

Lately there has been some interest in aluminum bearings. Metallized crankshafts have run into some difficulties here. If trouble ocurs, it is in the running-in period. Once past that point, metallized shafts have operated very successfully in aluminum. For example, cranks run in in babbitt bearings have given no trouble at all when aluminum bearings were substituted for the babbitt ones. The cause of this problem is not fully understood, although it seems reasonable to believe that aluminum, being a very high coefficient of friction metal may have greater tendency to seize in the early stages of operation. The obvious answer is to avoid aluminum bearings with metallized cranks until the matter is better understood.

Cylinder Liners

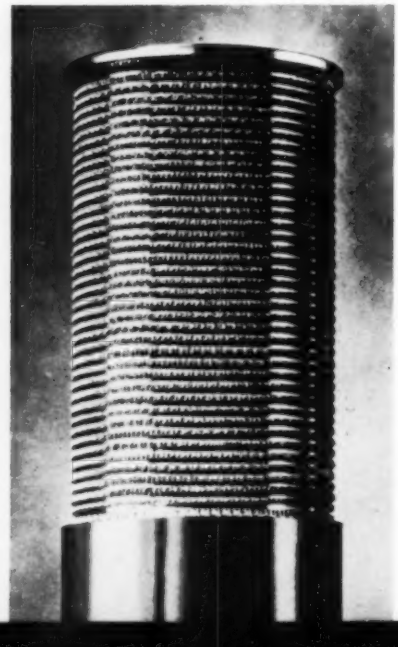
Preparation of cylinder liners for metallizing is quite as important as on crank throws and mains. In fact, the strongest method of bonding should always be used. Any shrinkage of the sprayed metal will work against the bond on inside diameters, where it helps the bond on the outside. The square threading and rotary shaft tool method is the best, without doubt.

It is an excellent idea to preheat the liner to around 400° F., too. This permits the coating and the liner to shrink at about the same rate, and a much tighter bond results. Heating has been done successfully with a torch, applied to the outside of the liner while it revolves in the lathe. The torch is moved across the surface and a certain amount of heat built up before the spraying is started.

In spraying, it is generally necessary to use an extension on the gun. On small diameters, a 45° angular air cap is mounted on the end of the extension. This permits the nozzle of the gun to remain 5 in. to 6 in. away from the work surface and prevents overheating. Spraying should not generally be attempted where the nozzle will be less than 4 in. from the work surface; .80 carbon steel or the medium-chrome, medium-carbon stain-

Figure 3. Electrical method of surface roughening in preparation for metallizing.

Figure 2. Shaft prepared for metal spraying operation.



less steel should be used for liner work. Their low shrink helps greatly, and their hardness and wear resistance make them serviceable for longer periods of time.

Pistons

Diesel engine pistons have been rebuilt very successfully. They present no particular problem. Here again, square thread and rotary shaft tool preparation are the recommended method. Straight grooves should be cut about ⅛ in. in from the edges of the lands and spaced about like a 14 thread. The electrical bonding method previously described, applied over grooves or threads produces a good bond, particularly over narrow lands.

The illustration at the head of this article shows a piston from an Ingersoll-Rand diesel locomotive being metallized. Preparation here was the square thread and shaft tool. Final machining of the metallized iron coating was done with Carboloy tools. Such tools, operating at fairly high speeds, and set just above center to produce a burnishing effect, give sprayed metal a very high finish.

In this case, ring grooves were metallized as well as the lands and the body of the piston, so that thinner, more efficient rings could be used. This assures a better seal and less blow-by. For those who have older diesels, here is a possibility of not only rebuilding the worn parts, but bringing the unit up to more modern high compression and efficiency during operation.

Valve Stems

Diesel valve stems which have been restored to service by rebuilding with medium-chrome, medium-carbon stainless steel. Besides giving a hard, wear-resistant surface, this metal has excellent resistance to sulphur gas pitting. Many sizes of valve stems have been done over the years for stationary engines, fishing boat engines and other types.

An excellent way to prepare these is the application of the sprayed self-bonding undercoat. This makes a good bond for the stainless steel. Care should be taken to clean the surface thoroughly before applying the undercoat, as it will not adhere to anything but a clean surface.

Other Applications

There are other parts besides these common ones for metallizing. Figure 4 shows a tractor oil pump drive shaft being metallized with stainless. Shaft work of this kind is pretty straightforward metallizing work. Wrist pins are something more of a problem due to their hardness, but the electrical method and the self-bonding undercoat are both applicable to hard base metals.

There is another possibility for wrist pins. A hard-facing material has recently been developed for metallizing application. It comes as a powdered metal made up into wire through the use of a plastic binder. When sprayed, the plastic volatilizes and disappears, leaving the metal alone on the work. The material is sprayed like any other metallizing wire, but feeds a little slower through the gun without causing any inconvenience.

Once sprayed on, the coating is heated to about 1900° F., which fuses it to the base and makes a homogenious and very hard coating. Heating is often done with a torch while the work is rotating in the lathe. The torch is run over the surface lightly several times until it is heated to about 600° to 1000°. Then the torch is moved to within about ½ in. from the surface, starting at one end, and moved along as fast as the coating becomes fused.

The fusion point is easy to recognize, for the coating takes on a shine or gloss as soon as this point is reached. Fusing causes the coating to shrink about 20%, so an allowance must be made for this in the spraying. Don't cool such parts too fast, as they may crack.

The hard-facing metal can be ground with a green grit silicon carbide wheel. Carborundum Company has made tests on this material and recommend their number BC36-K6-VE Silicon Carbide vitrified wheel using a coolant consisting of 1 part soluble oil to 60 parts water. Work speed should be about 27 surface feet per minute and wheel speed about 6400 surface feet per minute. For minimum stock removal but better finish, they recommend their C60-K6-VE wheel.

Finishing Sprayed Metals

In finishing sprayed metals, it's always a good idea to use cemented carbide tools such as Carboloy or Vascoloy-Ramet. Machining speeds can be higher with resulting savings in time and better finishes. Tools should always be set slightly above center, as the burnishing effect helps the finish too.

In grinding sprayed metals, don't attempt to use standard wheels. They fill up too rapidly. A fairly coarse grain, low bond strength wheel is much better and less redressing is necessary.

Conclusions

It will be of interest to our readers to note that metallizing has long since served its apprenticeship and is an accepted method for carrying out economical mechanical maintenance by the re-building of parts that would otherwise have to be replaced at a very much higher cost.

Many people have been under the impression that while it certainly offered prospects of low cost repairs, the process was not sufficiently developed to warrant its extensive use.

This is not true and wit hthe advent of new improved methods such as the low-pressure gun, metallizing has become common practice in many industries where low cost maintenance work is of paramount importan..

For example, one of the most widely used mechanical parts is the roll. While all rolls cannot be metallized, it is certain that a large proportion can be so repaired, and, in fact, many are being repaired in this fashion.

As further evidence that metallizing can be successfully carried out in diesel maintenance, it should be noted that many of the parts metallized in machine and metal working parts, power plants, textile mills, etc., are of a very similar nature to those mentioned in this article.

The following list gives a few of such parts:

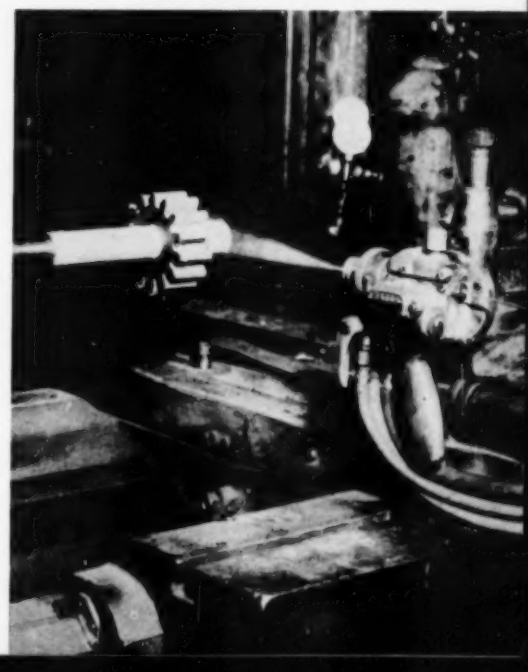
Name of part	*Metal used*
Agitator shafts	Stainless steel.
Armature shafts.	.10 carbon steel.
Compressor crankshafts.	.10 or .80 carbon steel.
Compressor pistons.	.25 carbon steel.
Compressor piston rods.	.80 carbon steel or stainless.
Pump packing sleeves.	Hard stainless.
Turbine rotor shaft packing areas.	Hard stainless.
Roll journals.	.10 or .80 carbon steel.
Stamping press crankshafts.	Hard stainless.
Motor Shafts	Carbon Steel
Gate Valve Stems	Stainless Steel

Metallizing is really coming into its own for the rebuilding of worn diesel engine parts. Those who are not altogether familiar with the process can well afford to investigate it further.

Those who are familiar with this modern "putting-on" process may reap even greater dividends by reviewing the situation and looking for more places where metallizing may be the answer to wear, lubrication or the problem of too many odd sizes.

The photographs used in this article are through the courtesy of Metallizing Engineering Company, Inc., Long Island City 1, N. Y.

Figure 4. Spraying stainless on tractor oil pump drive shaft.



TOMORROW'S DIESEL SERVICEMEN

By EDWIN B. ROSSMAN

EDITOR'S NOTE: The need for trained Diesel service personnel has been accentuated since the war. Several Diesel engine manufacturers have instituted training programs to alleviate the shortages within their own dealer organizations. The Michigan Diesel School, Inc., is helping to provide a solution to the shortage of trained mechanics which confronts the industry. The apprentice system of training men for any industry is outdated. Few individual manufacturers and distributors can devote the time and personnel to training competent Diesel service help.

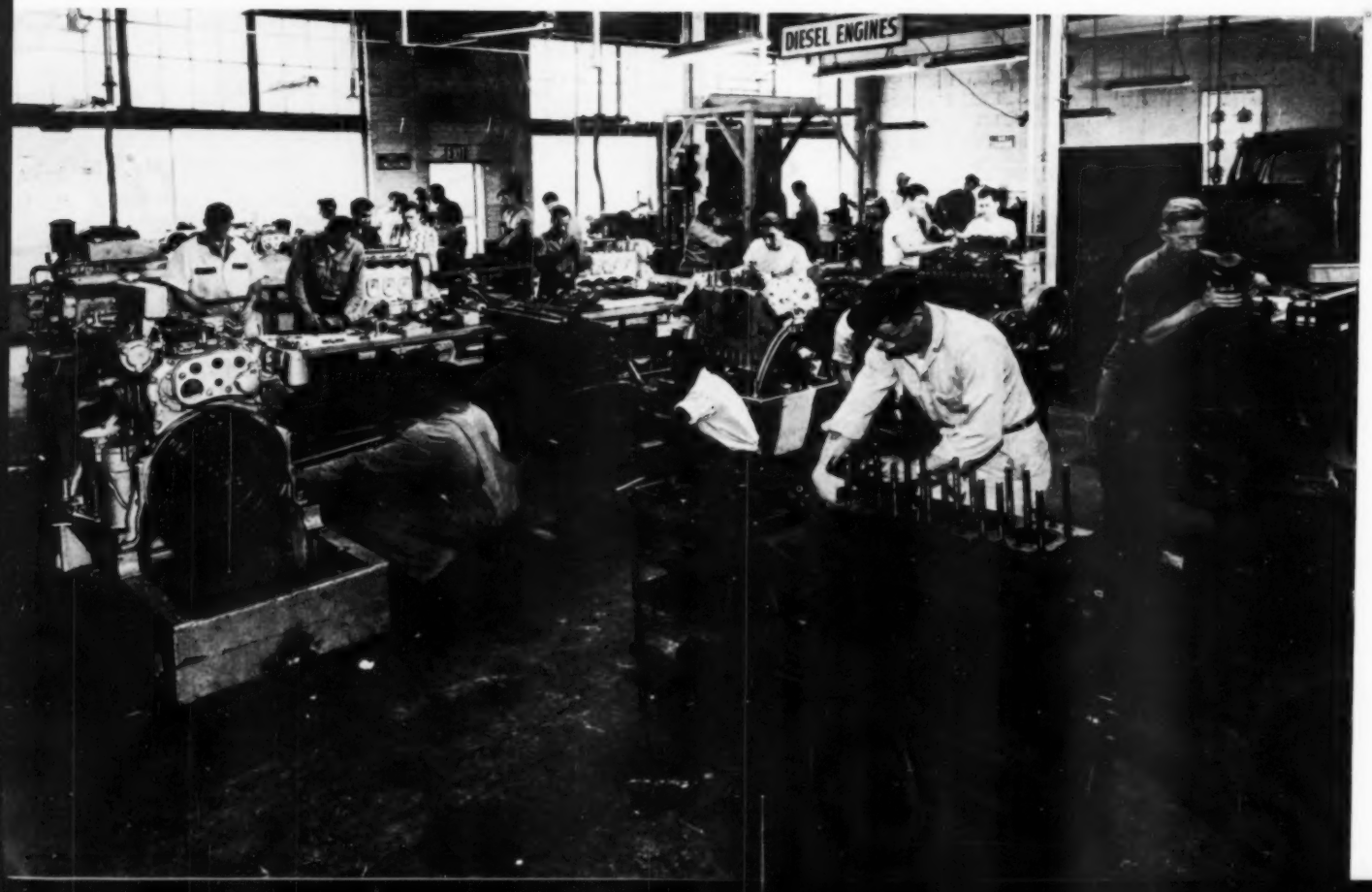
THE country today is going through the greatest educational boom in its history. While the universities and colleges are swollen with students in quest of higher education, there are a number of students with a practical eye to the immediate future, who prefer to learn a trade that will provide a short-cut to a better job and better wages.

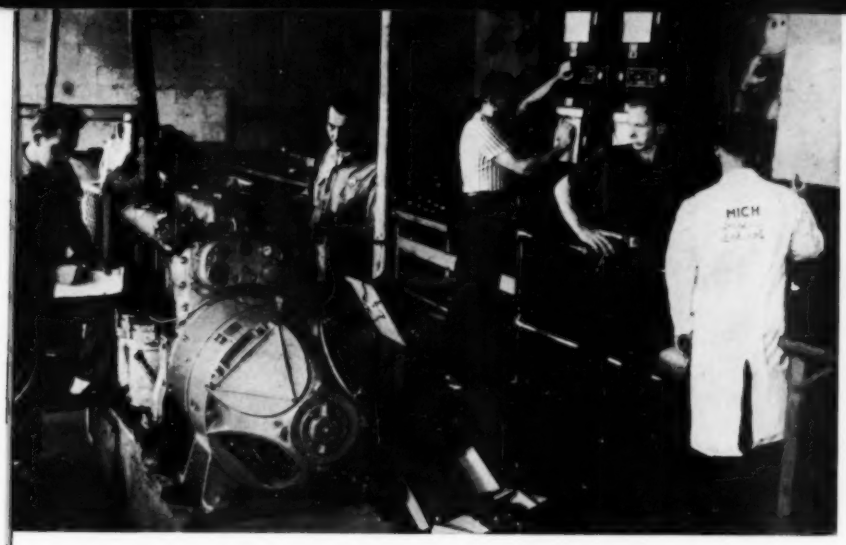
This group is composed largely of veterans who are taking advantage of educational training under the G.I. Bill of Rights. The student, going to the trade school, means business and wants fast practical training in an industry that will give him a future at a good hourly wage. He wants this training in an industry that is not overcrowded so that he will not face keen job competition. He seeks this training in a sound well-staffed school, specializing in a practical trade; such a school, for instance, as Detroit's Michigan Diesel School, Inc.

Students at this school receive complete all-around training in diesel engines and truck maintenance. They not only learn the "why and how" but get practical "learn-by-doing" experience by actual shop practice on late diesel and truck equipment under actual service conditions.

It is the aim of the school to meet the demand in today's industry for men well trained in theory as well as practical working knowledge.

Partial view of engines division at Michigan Diesel School showing students disassembling and assembling engines. Each student must completely rebuild, start and test a diesel.





Students making final power test on a diesel engine.

Checking and calibrating fuel injection equipment under the watchful eye of an instructor.

Therefore, the course covers the basic principles of the diesel engine, design, construction, type, application, preventive maintenance, supervision, operation and the actual shop practices of complete unit and component parts rebuilding.

Training comprises 34 weeks of intensive class and shop instruction, including 40% theory and 60% practice. Classes are held 5 hours a day, 5 days a week. Instruction is acquired in many phases. Each department is headed by an instructor especially skilled in the phase he is assigned to. These instructors are chosen from top flight diesel service maintenance and repair men, whose names and experience are well known.

Visitors are impressed by the elaborate layout of modern diesel equipment used. The embryo student is thoroughly trained in the fundamentals of welding. He is given an opportunity to get practical experience on acetylene and electric arc welding equipment. Later he will apply this basic training to diesel installations and repairs. The use of precision instruments, micrometers, dial and surface gauges, etc. are taught as is practical application of these instruments in the shop on various engine parts.

Also included in the basic phase of training are transmissions, final drive units and other units that are used in conjunction with diesels. To complete the students' orientation in the basic training division, time is spent on various units, such as all types of injection equipment—governors, blowers, superchargers, water pumps, and electrical systems. The student disassembles, reassembles, tests and trouble shoots each and every particular unit.

From this point on the course is devoted to training on the disassembly, assembly, testing, trouble shooting and maintenance problems of all popular makes of diesel engines. The student makes final tests of loading an engine under actual operating conditions, where he has to tune it to pull a full required load.

Class room instruction includes the latest in visual aids. These include lectures, demonstrations by blackboards, charts and cutaways. Working cutaways of actual units are a popular visual aid in this school. Prominent, too, in the school's curriculum are the best and latest in motion pictures and slides as reproduced by the industry.

The objective of the course is to give the student practical all-around training so that he is equipped to operate and service, install and repair all types of diesel engines. He become intimately familiar with the sizes, appearances, kinds and functions of parts and assemblies of most leading engines and equipment in use today. Among the engines on which the student receives actual experience are Buda, Cummings, Hercules, Fairbanks-Morse, Dodge, Mack, G.M.C. and Shepherd and Hill and others.

Fuel injection systems of all types are given special emphasis in the course so that the student has a thorough understanding of the injection systems' functions. Test stands for injectors and calibrating of pumps are used by the students to test units after rebuilding.

A unique phase of the course at the Michigan Diesel School is the truck maintenance section. The time in this division is allocated to the removal, repair and replacement of truck engines. These truck units are completely disassembled and assembled. After re-installation the engine is started and tuned up for final inspection. Included in the truck phase of the training is work on transmissions, clutches, rear axles, drive shafts, steering gears and brakes.

In the final phases of the course each student is required to disassemble and assemble each different make of engine, start, test and trouble shoot various pre-set problems. Final tests consist of starting and testing an engine with a load. The object for the student is to locate and repair all mal-functions until the maximum horsepower of the engine can be obtained. Recordings are made of the horsepower, speed, exhaust, temperature, exhaust smoke, balanced load and water temperature.

Not only does the student learn the correct assembly sequence, trouble analysis and servicing techniques but he learns the use and care of tools, gauges and testing equipment throughout the course. Emphasis is placed on using the proper tools for a job. Approved recommended kits of tools are furnished to the many veteran students in training under the G.I. Bill. They become the veteran's property upon completion of his training. This provides him with the tools with which to go to work upon receiving his diploma.

Students are required to complete each job as scheduled and be graded on their work before their next assignment. Progress must be satisfactory or the student is not recommended for further training. On the completion of each course, competent graduates are recommended for work in the industry. Many employers look to the school regularly for graduates to supplement their existing staff.

One of the most serious difficulties met in the past by the diesel industry has been the complaint of the lack of skilled diesel operators and maintenance men. In some localities this has not only occasioned operational difficulties in existing installations but has heightened sales resistance as plant executives have sometimes hesitated to acquire diesels through fear of being unable to secure the necessary trained men to run them.

By giving a complete and practical training in diesel operation and maintenance, such schools as that described in this article are going far to remedy this situation. Diesel plant owners know that a man who has successfully completed such a course will be capable of successfully taking care of their engines. The mere fact that such men have undertaken such a strenuous course also indicates that they have all-important interest in their chosen field.

Earl Carsten, General Manager of the Michigan Diesel School, Inc. invites distributors, dealers, fleet owners, garage owners, who are looking for capable men, to call upon the school. Mr. Carsten also extends an invitation to all interested in the diesel industry to visit this modern school.

BRITISH-BUILT DIESEL-ELECTRICS FOR EGYPTIAN RAILROAD

By WILL H. FULLERTON

WE feel that this description of the mechanical equipment of a British-built Diesel-Electric locomotive will prove of interest to our readers.

The Egyptian State Railways have, in the last few years, undertaken a considerable program of replacement of steam rolling stock by Diesel-electric units, and among the orders placed in Great Britain was one for 15 Diesel-electric switchers, all of which have been despatched and satisfactorily set to work, and another for twelve 1600 h.p. Main-line passenger locomotives. Of the latter, the first unit is currently being shipped to Egypt, while the remaining locomotives are in the course of construction. Further orders have also been placed with The English Electric Company for similar equipment.

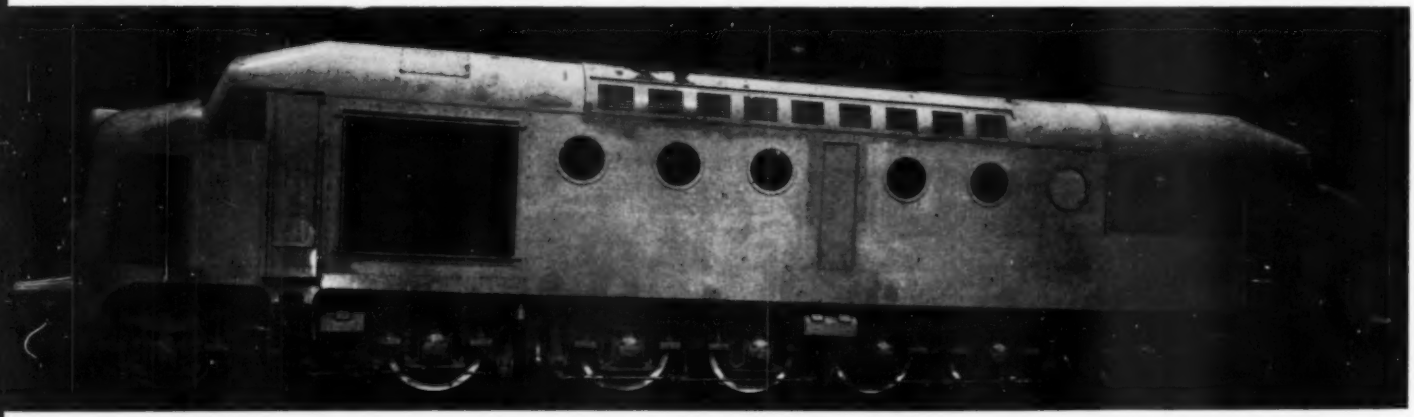
The relatively wide loading gauge permissible on the Egyptian State Railway has enabled the company's designers to achieve an internal layout for the 1600-h.p. main line locomotive described here in which there is ample room for access to all parts of the gear, and the disposition of the fuel tanks on the underframe has meant that adequate and unobstructed walking ways are provided from end to end. Except for the two driving cabs, which are cut off by hermetically-sealed doors, there is no bulkhead anywhere in the engine and no seperation into individual compartments. The engine is a 16 cylinder, V-type, 4-cycle, turbo-charged diesel, with a rating of 1600 h.p. Specially developed for railroad service, it was used on the first two Main-line passenger locomotives on British Railways in the early part of 1948.

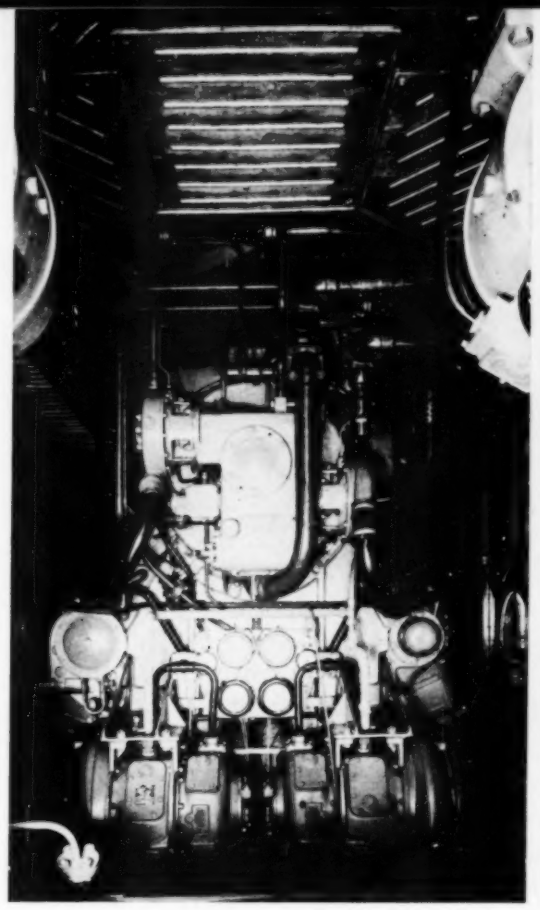
The cylinder bore is 10" and the piston stroke 12". Individual fuel pumps are operated through roller followers from two high level cam shafts, and these are arranged in outboard fashion along each bank of cylinders. Monobloc construction is employed for the cylinder jackets and crank case, with two high grade iron castings joined transversely. The cam shafts, which are built up in relatively short lengths to facilitate removal, are housed in compartments formed in the upper portion of the combined monobloc casting and are driven from the fly-wheel end of the engine by means of spur gearing and triplex roller chain. The bedplate, which is a single casting, has transverse webs forming housings for the nine main bearings, while the lubricating oil sump is incorporated as an integral part.

The generator body is bolted and registered to an extension of the bedplate at the fly-wheel end. The crank shaft is hardened and tempered and runs in sleeve type metal bearings having steel shells. A vibration damper is fitted to the free end of the crankshaft, and a drive is taken from this point for the lubricating oil, water and fuel transfer pumps. The water and lubricating oil pumps are in duplicate, each water pump serving one bank of cylinders. Oil is drawn from the engine sump by one pump and is circulated through the oil radiator, while the second pump takes the oil from the radiator circuit and delivers it through filters, to the crank shaft main bearing. Forced lubrication is also applied to the cam shaft bearings, cam shaft drive and pump drives, while the valve gear is lubricated at reduced pressure.

The engine governor is driven from one of the cam shafts and is mounted on the fly wheel end of the engine. Regulation of the fuel pumps is obtained by a servo-piston operated from the lubricating oil system. In the event of a failure of oil pressure, the engine is automatically stopped. The four exhaust gas turbo-chargers are of British Brown Boveri manufacture, and each serves four cylinders. Self-contained automatic lubricating systems are installed for these components, which are thus lubricated entirely independently of the engine system.

English Electric Company's 1600-hp diesel-electric locomotive for Egyptian State Railways.





End view of engine installation on Egyptian State Railways Locomotive. Note turbo-chargers.

The 16 cylinder V-type, 4-cycle, turbo-charged diesel engine and generator.

ENGINE AUXILIARIES

Engine starting is accomplished by motoring the main generator from the storage batteries. An interlock is so arranged that the starting connections cannot be made until the requisite oil pressure has been built up in the engine lubricating system, by the operation of a motor-driven priming pump. An over-speed trip device is employed, which automatically stops the engine if it should exceed a predetermined rate of rpm. In the air delivery manifold from the turbo-chargers there is a fuel limiting device which automatically reduces the maximum power developed by the engine should a turbo-charger fail. Combustion air for the diesel engine is taken in through filters in the side of the cab and is ducted to the intake, the ducts being cross connected to ensure a supply of air under all conditions.

Specially large radiators, in view of the semi-tropical conditions under which the engines will have to operate, are provided in each bodyside. The radiator fan is placed in an opening of the roof on the center-line of the engine, and exhausts through a grille at the top. Speed of the fan motor is controlled by relays and thermostats. The engine is situated centrally with generator directly coupled to one end, while the auxiliary generator is outboard mounted on the free end of the main generator. The main generator is a single bearing machine, and is directly coupled to the engine crank shaft. It is provided with two separately-excited field windings and a series de-compounding winding, which is also brought into use when the generator is motored from the battery for engine starting purposes.

The wheel arrangement is of the 1A-Do-A1 type with six axle-hung nose suspended traction motors, driving the motored axles through single reduction spur gearing. Pairs of motors are connected permanently in series, and are of the D.C. series-wound reversible, forced-ventilated type. Roller type armature bearings are used, arranged for grease lubrication, while the nose-suspension bearings are of the sleeve type with oil lubrication; pinions of nickel steel, case-hardened and ground, are used, and the gear wheels are constructed of carbon chrome steel.

The main control frame is mounted lengthwise adjacent to the engine at the generator end and consists of electro-magnetic and electric-pneumatic contactors and relays. It is mounted in a single dust-tight cabinet. The auxiliary generator provides power for the two traction motor blowers, the control circuits, battery charging, the compressors for the locomotive brakes, the exhausters for the vacuum brake for the train, locomotive lighting, and similar auxiliary purposes.

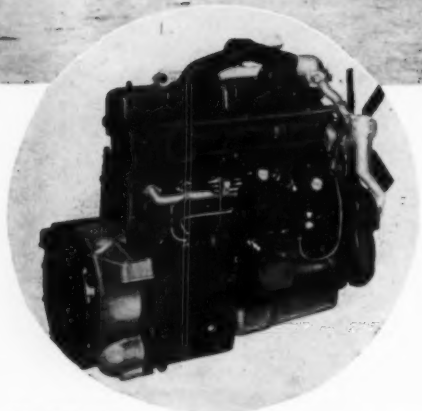
The radiator fan motor is supplied with power from the main generator. The traction batteries are of the lead acid type and are of 200 amp.-hr. capacity. They are neatly stowed away in accessible compartments at floor level.

Air for the main generator and auxiliary generator is taken in the same way as that for the combustion air for the main engine—through louvers and filters. The traction motor air supply, taken in the same manner, is then forced by the traction motor blowers to the respective motors via metal ducts terminating in flexible bellows at the motors. Air expelled from the generator passes out into the engine room where it leaves the cab through roof louvers which are equipped with controllable shutters which, in the case of a sand storm, can be closed on one or the other side of the locomotive.

A feature of the dry filters is that they can be easily cleaned while the locomotive is in service which greatly facilitates maintenance. It will be realized that due to the possibility of sand storms, great care had to be taken in the design and layout of air passages in order to preclude sandy contamination of working parts and consequent breakdown.

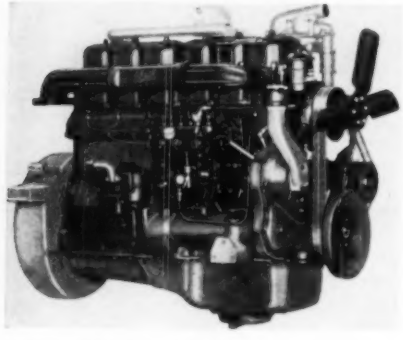
All the oil engines and electrical gear for the twelve locomotives are being constructed by The English Electric Company, who are the main contractors. The mechanical portion of the locomotive has been designed jointly by The English Electric Company, and the Vulcan Foundry Limited, the latter Company having provided the detailed design of the running gear and main frame. Six of the locomotives are being built and erected in each company's works.

The Mack diesel-engined tractor pulling a semi-trailer in which three entirely new diesel models are shown throughout the trip.

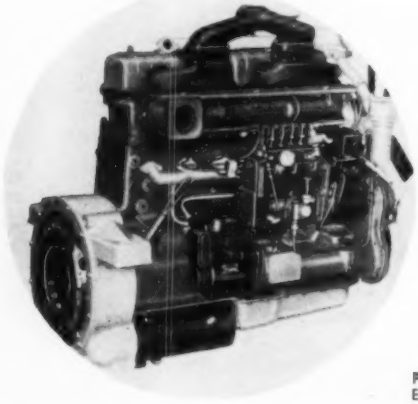


The END 457, the diesel engine that pulled the truck unit the first lap of the tour, is rated at 110 hp. at 2200 rpm.

MACK'S MOBILE DIESEL EXHIBIT



The END 672, largest of the three new diesels exhibited, has a rating of 165 hp. at 2000 rpm.



Pulling the traveling unit on the last part of the tour is this END 510 diesel engine which is rated at 135 hp. at 2200 rpm.

A UNIQUE mobile exhibit, at present on a five month tour with Mr. A. G. Crockett, director of market research for Mack-International Motor Truck Corporation, in charge, made its original appearance in New York recently.

A Mack die-el-engined tractor pulling a semi-trailer in which three entirely new diesel models were shown, the END 457, 519 and 672, was the main attraction. Mack is directing these three diesels particularly toward tractor-trailer combinations, 40,000 pounds G.C.W. and up—a range which enables the company to offer diesel-engined units to meet any legal requirement of any state of the Nation.

To haul the Mack exhibit on its first lap of the trip, Mack is using one of its EHT tractors driven by an END 457 diesel engine which is rated 110 horsepower at 22000 rpm. Later on in the tour this tractor will be replaced by a Mack EQT tractor driven by the company's END 510 diesel engine with a rating of 135 horsepower at 2200 rpm. The complete trailer-tractor unit is 44 feet overall in length, and can attain a speed of better than 60 miles per hour at 40,000 pounds gross, enabling it to keep up with passenger car traffic on the open highways. The END 672, largest of the three diesel engines exhibited, has a rating of 165 horsepower at 2200 rpm.

Also displayed in the trailer is an exploded END 672 working diesel engine, and an END 457 complete as it comes off the production line as well as a working model of the Mack Mono-shift transmission to show the speed and grade ability of the EQT diesel-driven tractor with over-geared transmission. A panel with cut-away sections of the complete Mack diesel fuel injection system is also displayed.

Controlled fuel distribution on the Mack diesel engines is obtained by an American Bosch multiple-unit type fuel to all cylinders achieving uniform power strokes without wasting fuel. The governor working in conjunction with the fuel injection is a Woodward. A Leece-Neville is used for the starting motor and the generator is a Delco-Remy. Fuel oil is filtered through a Purolator radial fin type micronic filter. The air brake is a Bendix-Westinghouse product.

Another of the Mack diesel features is the variable and automatic injection timing which is synchronized to the speed of the engine provided by the Synchrovance, a Mack development. The result is available power and torque at all speeds, with minimum peak pressures and less combustion shock, which produces a smooth running engine.

Final scheduled stop for the tour of this diesel tractor-trailer is the annual meeting of A.T.A. to be held in Boston in October.

DON'T BE SATISFIED WITH HALF-WAY MEASURES...

insist on Walseal® products and be certain

— the FACTORY INSERTED Ring insures FULL PENETRATION of the Silver Alloy . . . a perfect joint

Today, contractors . . . builders . . . architects are using brazed connections, in ever increasing numbers on their brass and copper pipe runs. However, they must be certain that the correct brazing alloy is used; that the joint has penetration of alloy up the shoulder of the fitting.

That's why more and more are turning to Silbraz® joints made with Walseal valves, fittings and flanges which assure the proper amount of alloy with no waste. They know that the finished joint not only will withstand hydrostatic pressure, but it will also withstand terrific impact and vibration — in fact, no correctly made Silbraz joint has ever been known to creep or pull apart under any pressure, shock, vibration or temperature which the pipe itself can withstand.

Furthermore, it is a relatively simple operation to make a Silbraz joint — no heavy scaffolding need be erected . . . just cut the pipe, flux, assemble, then braze, following the technique recommended by the Walworth Company. A silver brazing alloy — FACTORY INSERTED — in each port flows out when heated with the oxyacetylene torch, making a joint that is stronger than the pipe itself . . . a one-hand operation, with the mechanic out of the path of the deflected heat — at all times.

For full information about Silbraz joints made with Walseal products, write for Circular A-1.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

High-Speed Diesels . . . Design, Operation & Maintenance

CONDUCTED BY **H. G. SMITH**

Lower Maintenance Cost

A few points about what should be done and what one operator did to drastically lower his operating cost.

DIESEL powered equipment has gone a long way in reducing the cost of digging coal and iron and hauling dirt to build roads and dams. The very fact that diesel engines are used today almost exclusively in such equipment proves beyond a doubt that they have set the pattern for lower cost of operation.

When this transition period started, changing from steam and gasoline engines to diesel, a big step was taken and the resulting savings in operating costs were not made in pennies but dollars. If a new source of power is found that would make as big a step as the diesels did, then we could expect the diesel to be discarded in its favor, but not until then.

Right now there is no such prospect, so the crumbs of bad operation, poor application, etc., that have been dropped along the way must be picked up and put together to make a better loaf of this marvelous Diesel Power Plant.

There has been and still exists a lot of resistance to the higher original cost of the diesel powered equipment and it is justified, providing the original investment is the only consideration.

It no doubt can be safely said that the operator who does not have sufficient hours of operation per year to amortize the extra original investment is justified in his resistance and to help him, as well as the big operator, it is the duty of those with the know how to exploit every angle of operating cost.

The diesel engine and equipment manufacturers have been and still are doing an excellent job to bring these prices down but paralleling this work the actual operating costs must be carefully studied to justify the present invesment.

To cut the cost of operation it becomes necessary to find and develop new methods, things that have not been done before, and broaden the use of those that are already known. Looking back over the old operating records will show that the cost of operation, when the diesel was first introduced, was far more than it is today, so there is no set standard unit of operating cost. The standard of today will not be good enough tomorrow.

H. G. Smith's background in diesel engineering renders his articles of great interest to those engaged in operation and maintenance of high-speed engines. From the Springfield, Ohio, Technical and Engineering school, he entered the Foos Gas Engine Company, Springfield and later, Springfield Motor Truck. With this experience behind him, he joined Hercules Motors Corporation where he was chief engineer for many years being with them when their diesel program was started. Executive engineer for Buda during the last ten years, he recently resigned to take up consulting work.

Some operators may have the edge on their competition and for this very reason compel a competitor to examine his operating cost. In the process of trying for a reduction a lower unit cost of operaing is established. If an operator sits back and waits until some other fellow develops cheaper methods and then just follows suit, he will find it difficult to keep up with the parade.

The most progressive operator in any particular field is usually the one that establishes the standard and the others must try to equal him. History, however, will show that this leadership has a tendency to shift quite rapidly.

Each operator can do his share if he continually examines his operation, not necessarily from his cost sheets, but from the actual operating view point. The great difficulty is to actually spot the "parasites" that eat away the profit. Those that are quite obvious and easy to overcome are not the troublesome ones because they can be corrected too easily. If real progress is to be made the ones below the surface are the ones to be attacked.

In the August issue of DIESEL PROGRESS there is an article on "Preventive Maintenance" suggesting some things to be studied to reduce maintenance costs. On page 54 there is mentioned, that one operator in the Mesabi Iron Range, reduced his operating cost by installing recording instruments on his fleet of trucks. He had approximately one hundred trucks bringing iron up out of the pit, which required about 90 drivers. His labor market was of the usual caliber and he had to use what was available. Very few men had any previous experience and consequently his "unavoidable accidents" were extremely high. He classed those failures that were unexplainable as "unavoidable accidents."

A tabulation was made by truck and driver number, listing all failures such as engine, clutch, axle, transmission and tire changes, etc. By coordinating these failures to the driver he decided that he had two classes. He separated them into Class A and Class B. He arbitrarily set 20% as a maximum down time for a good operator and found that 85% were Class B and only 15% could be given the Class A rating.

He watched those drivers that were having the most failures, but he still could not find out why. Failures indicated that overspeeding was the major cause but no positive evidence was obtained to prove it was true. Warnings were issued about overspeeding but the trouble continued.

Sealed recording instruments were decided upon and installed on each vehicle. The drivers were not told exactly what the instruments would show. Immediate improvement, however, indicated that some of the drivers knew what they were. Others apparently didn't care as shown by the charts studied after the first week. Some charts which showed overspeeding were selected and the entire group of drivers were called into a meeting. The bad and good charts were projected onto a large screen to be seen by the drivers.

Overspeeding on the down grade into the pit was clearly shown. By comparing the charts with the records of the maintenance crew it was discovered that the unusual accidents and failures were definitely tied to overspeeding. These classes were continued weekly and by doing this one thing his percentage of bad to good drivers actually reversed itself in 3 months. The chart "A" shows the gradual change between the two classes.

In cooperation with the engine and truck manufacturers he gave his men a weekly lecture along with showing them the change in their daily charts. Part of one of these lectures is worth repeating below and we give it without change.

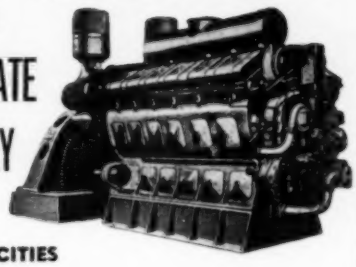
. . . . *And now please turn to page 62* . . . .

DIESEL GENERATOR SETS

FOR

IMMEDIATE

DELIVERY



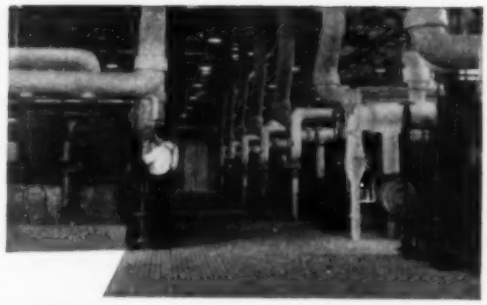
UNIT CAPACITIES
10 TO 1420 KVA

A.C. 50 AND 60 CYCLES
ANY VOLTAGE

Write or wire today for bulletins and complete information regarding these fine fully guaranteed DIESEL ENGINE GENERATING UNITS.

AG SCHOONMAKER CO INC.
54 CHURCH STREET NEW YORK 7, NEW YORK

Plants and Warehouses: Jersey City, N. J., Sausalito (S.F.), Cal.



POLYMER'S 43 engines equipped with HONAN-CRANE

Honan-Crane oil purifiers are installed on twenty-five 300 hp Worthingtons and Ingersoll-Rands, and eighteen 800 hp Ingersoll-Rands by Polymer Corporation, Sarnia, Ontario, Canada.

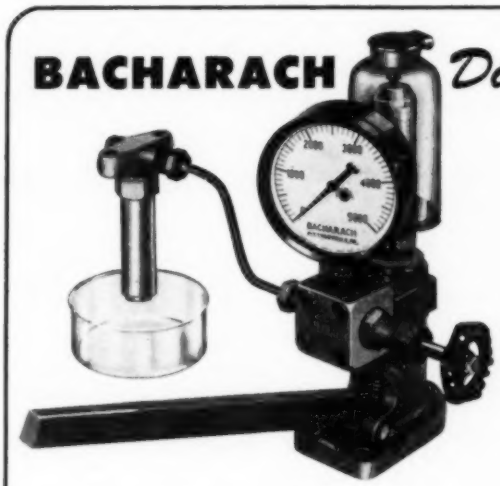
Engineer C. P. Ambler maintains a continuous 24-hour operating schedule, with no crankcase changes. Time between engine overhauls has been extended by 5,000 hours.

For full information on low cost purification of diesel fuel and lube oils, write to 202 Indianapolis Avenue, Lebanon, Indiana.

CLEAN OIL ENGINEERING

HONAN-CRANE CORP.
A Subsidiary of **HOUDAILLE-HERSHEY CORP.**

BACHARACH *Diesel* NOZZLE TESTER



This nozzle tester is manufactured with the tools and under the patent rights formerly owned by Aircraft & Diesel Equipment Corp. It is identical to the ADECO Nozzle Tester Model PH-25.

We can make immediate delivery of complete units, as well as of all spare and replacement parts for ADECO Testers now in use. We also will service and repair promptly all Nozzle Testers previously sold by Aircraft & Diesel Equipment Corp.

A wide selection of nozzle connectors and fixtures is available for making every recommended service test on all makes, types and sizes of Diesel nozzles and injector units.

For further information fill in and return coupon today.

Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh 8, Pa.

Send me literature checked:

☐ **Product Leaflet 613 on Bacharach Nozzle Tester.**
☐ **Technical Bulletin on testing and servicing fuel injectors.**

Name_____
Company_____
Street_____
City and State_____

BACHARACH INDUSTRIAL INSTRUMENT CO.
7000 BENNETT STREET · PITTSBURGH 8, PA.

"Overspeeding down grades and using the engine as a brake is causing a tremendous loss. Too many of you drivers don't realize that a diesel engine always has a wide open throttle *so far as the air is concerned*. When you are sliding down a hill or grade in gear, the cylinder head is being blasted with a tremendous amount of cold air and cooling it off after it has been heated to a high degree going up the grade. These sudden and drastic changes cannot be tolerated by a piece of cast iron or steel. The condition is bad enough when operating at normal speeds and becomes a very serious matter when the engine is run beyond its rated speed."

"Crankshafts and bearings are also subjected to abnormal stresses and loads under these conditions. A properly counterbalanced crankshaft will keep itself in line when the engine is firing, but when the engine is being driven by the vehicle it is not firing and the connecting rods and pistons are trying to fly off. Excessive loads are imposed upon the shaft and bearings that cannot be absorbed. Such a condition can only result in crankshaft and bearing wear."

"At these excessive speeds the valves are jumping up and down at a terrific speed and at times they will be hit twice before they ever land back on their seat, and when they do, the force is so great it will cause the stems and heads to be fractured. These failures do not always show up immediately so you don't realize what is happening but sooner or later a costly failure occurs."

Chart A
Drivers' rating

This lecture was typewritten and distributed to each driver and when a new man was hired, he was shown the charts and given a copy of the lectures. This operator had overcome one of the most serious things that, today, plagues the on-the-highway as well as the off-the-highway truck owners. The results were so satisfactory that other operators heard about what had been accomplished and they became interested.

Every operator can and should look for similar conditions in his diesel installations.

New General Motors Diesel Locomotive Plant for Canada

DETROIT—General Motors will begin the construction immediately of a Diesel-electric locomotive plant in Canada, it was announced today by C. E. Wilson, president.

Options have been obtained covering a 210-acre tract of land at London, Ont., where a plant with 226,000 square feet of floor space will be built, with plans for later expansion. The plant will employ about 1,000 persons at capacity and will draw parts and materials from many Canadian sources. It will have a capacity of one Diesel-electric locomotive per day and will build locomotives for all classes of railway service.

The plant operation and the distribution of locomotives produced in Canada will be by a new subsidiary of General Motors to be known as General Motors Diesel, Ltd. The Canadian subsidiary will work in close cooperation with the Electro-Motive Division of General Motors, builders of Diesel-electric locomotives in the United States with its principal plant at La Grange, Ill.

"The object of the move," said Mr. Wilson, "is to make available to Canadian railways modern and efficient motive power of the same type that has proved advantageous to American railroads.

"There is every reason to believe that the production of Diesel locomotives in Canada will bring substantial benefits to Canadian railways. In the United States, the railroads are actively carrying out a program of extensive Dieselization, as indicated by the April, 1949, Interstate Commerce Commission power reports which show Diesel locomotives supplying the motive power for 47.5 per cent of the yard switching hours, 31.5 per cent of the freight gross ton miles and 47.5 per cent of the passenger train car miles. By comparison, the use of Diesel power in Canada, with its great distances and weather extremes, will be even more beneficial to the railroads.

In addition to the benefits to the railways, the move will increase employment and the purchase of material and parts by General Motors Corporation in Canada.

"Another important advantage to the Canadian economy which will result from the use of Diesel power will be the use of the products of the great oil fields in the province of Alberta, which we understand are sufficient to meet all Canadian requirements for Diesel fuel oil and other petroleum products."

Selection of E. V. Rippingille, Jr., to be president and general manager of the new subsidiary has been announced by C. E. Wilson, president of General Motors. Mr. Rippingille was manager of plant No. 2 of General Motors Electro-Motive Division, near Chicago, until Aug. 1.

Mr. Rippingille, who is among the youngest of General Motors operating executives, was born in Brooklyn in 1910. He literally grew up in General Motors. His father, Edward V. Rippingille, is at present assistant general manager of the Research Laboratories Division of General Motors and has been employed by GM for 25 years.

When the younger Rippingille finished his education in Detroit, he entered the General Motors Institute at Flint, Mich., where he received training as a mechanical engineer. Since then he has had a wide range of experience covering many phases of manufacturing. After leaving GMI, his first connection was with the Cleveland Diesel Engine Division of General Motors. He joined the Electro-Motive Division in 1937 as a foreman, later was assistant master mechanic. He became assistant factory manager in 1942 and manager of plant No. 2 in 1946.

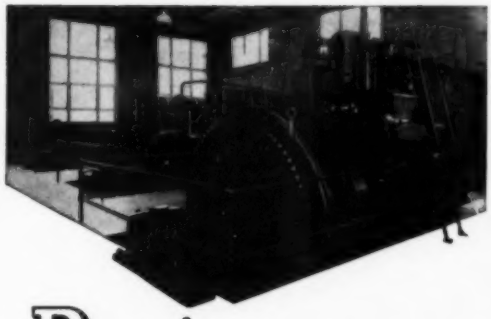
Mr. Rippingille is one of many GM men occupying key positions who are graduates of General Motors Institute.

Young Issues New Catalog

YOUNG Radiator Company, Racine, Wisconsin, and Mattoon, Illinois, announces the issuance of Catalog No. 1349 covering its complete line of Jacket Water Coolers for gas, gasoline, and Diesel engine cooling.

This Catalog, complete with illustrations of typical installations, presents in detail specifications and ratings of the entire line, including the larger capacity Master Series—12 models capable of dissipating from 505,000 to 2,270,000 Btu per hr in water cooling service under standard conditions. The Standard Series—also consisting of 12 models—handles from 151,000 to 490,000 Btu per hr under the same conditions of service. Model 25 is also cataloged. This is a compact, low-cost unit, which the manufacturer states has been especially designed for cooling the jacket water of gas and Diesel pumping engines of about 40 hp. Catalog No. 1349 also illustrates and describes the complete line of Young Jacket Water Cooler Accessories including details on the three types of cores available—for water, oil, or gas cooling.

Free copies of Jacket Water Cooler Catalog No. 1349 will be sent upon written request to the Company at its General Offices, Racine, Wis.



Paris POWER PLANT gets

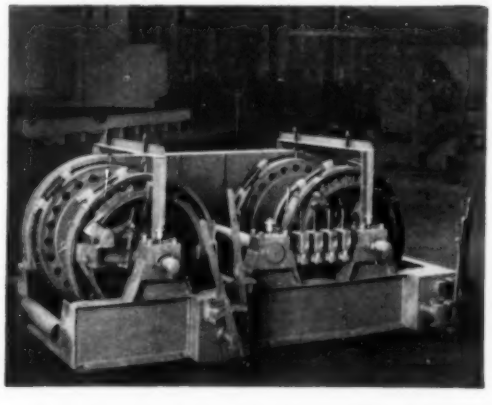
DEPENDABLE OIL PURIFICATION

Honan-Crane delivers dependable oil purification at the Municipal Power Plant, Paris, Kentucky, where four Fairbanks-Morse diesels meet the peak load of 2080 kw.

Superintendent Edgar Dodge reports power cost of $.0086 per kwh, delivered for continuous 14 year period without any interruption from engine failure. In this time, the diesels ran 141,955 hours.

For full information on low cost purification of diesel fuel and lube oils, write to 202 Indianapolis Avenue, Lebanon, Indiana.

HONAN-CRANE CORP.
a subsidiary of
HOUDAILLE-HERSHEY CORP.



CUSTOM BUILT MACHINERY

UNION Diesel facilities are available to build machinery to meet your specific requirement. Special **UNION** Diesel designed and constructed two drum boomwinch for HAVISIDE No. 7 is illustrated.

The UNION DIESEL ENGINE Co.
2200 EAST SEVENTH STREET
OAKLAND 6, CALIFORNIA, U. S. A.

YOUNG OFFERS THE "HC"

HORIZONTAL CORE

ANOTHER VERSATILE Vertical Air Discharge UNIT FOR . . .
- ✔ Jacket Water Cooling
- ✔ Oil Cooling
- ✔ Gas Cooling, Condensing
- ✔ Steam Condensing

Basic "HC" Unit may be used in multiples for greater cooling capacity or combination of services.

IMPORTANT FACTS ABOUT THE "HC"

- LOW COST—small initial investment, economical maintenance.
- VERTICAL AIR DISCHARGE—eliminates cross wind effects.
- HIGHLY EFFICIENT—airfoil section fan.
- MULTIPLE INSTALLATIONS—provide greater capacity, combined services.
- NO VIBRATION—adjustable pitch fan mounted separately from unit.
- LARGE CAPACITY—water cooling, from 600,000 Btu/hr up; oil cooling, from 20,000 Btu/hr up.
- LOW HP REQUIREMENT—1 to 10 hp per fan.
- EASY INSTALLATION—simplified piping and frame construction.
- CORE GUARD SCREEN—protects cores from falling objects.

● Here is another development by Young providing high efficiency cooling and condensing at low initial and operating costs. The Dual coil "HC" is designed for water and lube oil cooling. Manifolds are available for water cooling coils only. Four sizes, with 2, 4, 6 and 8 coil installations, provide exceptional versatility in heat transfer service. The 4 or 6 blade fan, serving each two coil unit, may be mounted directly on the fan motor shaft, or powered by a v-belt or gear speed reducer drive. Full details about the new "HC" Units, or other Young Heat Transfer Products, are available on request.

YOUNG
HEAT TRANSFER PRODUCTS

T. M. REG. U. S. PAT. OFF.

YOUNG RADIATOR CO.
General Offices: Dept. 409-J, Racine, Wis.
Plants at Racine, Wis., and Mattoon, Ill.

OIL FIELD, HEAVY INDUSTRIAL, MUNICIPAL & CHEMICAL PROCESS COOLING EQUIPMENT
Engine jacket water coolers • Oil coolers • Steam and natural gas condensers • Natural gas coolers • Evaporative coolers and condensers • "VAD" Vertical air discharge cooling and condensing units

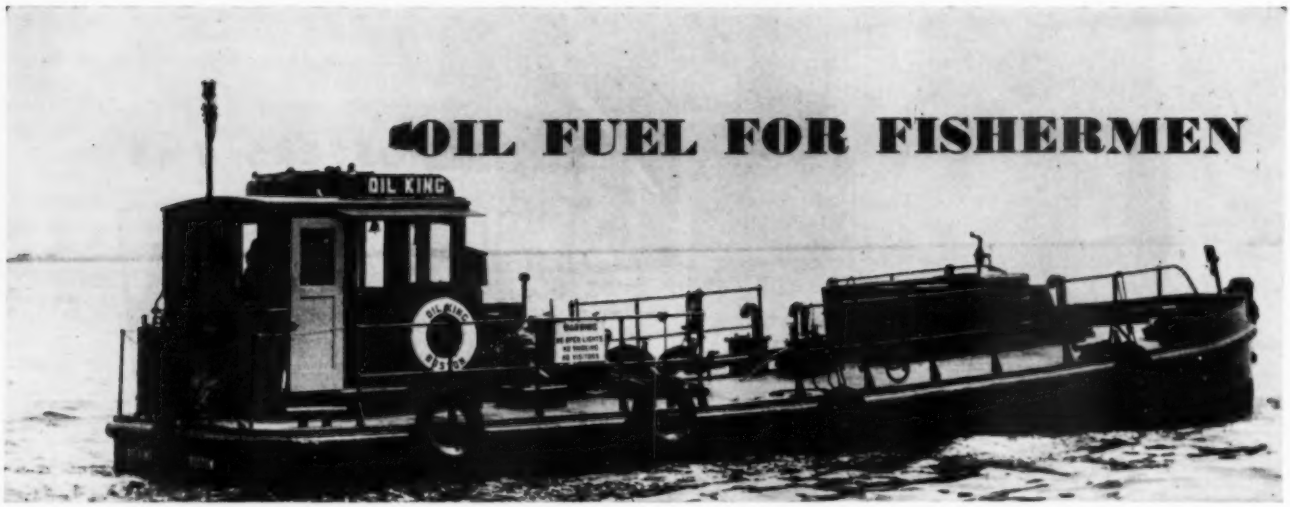
AUTOMOTIVE PRODUCTS
Gas, gasoline, Diesel engine cooling radiators • Heat exchangers • Intercoolers • Oil coolers • Supercharger intercoolers

HEATING, COOLING AND AIR CONDITIONING PRODUCTS
Convectors • Unit heaters • Heating coils • Cooling coils • Air conditioning units • Evaporative condensers

AERONAUTICAL PRODUCTS
Oil coolers • Supercharger intercoolers • Radiators • Heat exchangers • Valves • Regenerators

DISTRIBUTORS • The Happy Company, 310 E. 10th St., Tulsa 1, Oklahoma. Flournoy & Everett, Inc., 5043 Santa Fe Ave., Los Angeles 11, California. H. J. Young, 1364 Lake Shore Drive, Muskegon, Michigan. Others in Principal Cities.

OIL FUEL FOR FISHERMEN



"Oil King" en route in Boston Harbor.

By F. H. N. CARTER

TO economically re-fuel fishing boats in Boston Harbor by tanker presents quite a number of problems. The carrying capacity must be relatively high yet the vessel cannot be large and it must, of necessity, be highly maneuverable. The small tanker *Oil King* owned and operated by the Port Oil Company of Boston complies with these requirements.

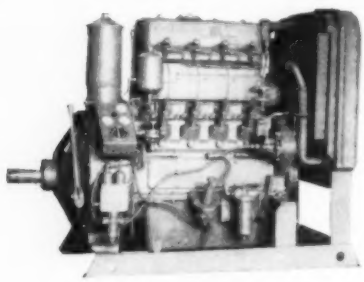
Outboard diesel engined, the *Oil King* has a length of 52 feet 9 inches, a beam of 15 feet 11½ inches and a depth of 6 feet 6 inches. The 40-hp outboard engine obviates the necessity for an engine room with its consequential larger hull and higher power requirement for equivalent carrying capacity. Complying to American Bureau of Shipping and U. S. Coast Guard requirements under tanker regulations, a two-man crew only is needed. The rated capacity is 16,000 U. S. gallons: maximum capacity, 20,000 U. S. gallons.

One feature of the patented hull design is that the boat always floats in the correct trim whether light or loaded. Of welded steel construction, the cargo space is divided into four separate tanks by oil-tight bulkheads—three athwartships and one longitudinally. The deck and shell plating is 5/16 inch and the bulkhead plating, ¼ inch.

Astern, a deck shelter over the engine space serves as combination pilot house and engine room for this compact craft. Electric navigation lights running off the starting battery are installed with lead and armour cable which is run in steel pipe conduit on deck.

Designed by Gordon Munro and built by Murray and Tregurtha, Inc., Quincy, Massachusetts, the hull is the well known "Duoform" design. The propulsion unit is a Murray and Tregurtha "harbormaster" driven by a Hercules 40-hp diesel equipped with generator and battery for starting.

Oil King is an excellent example of sound design for a special application at comparably low cost.

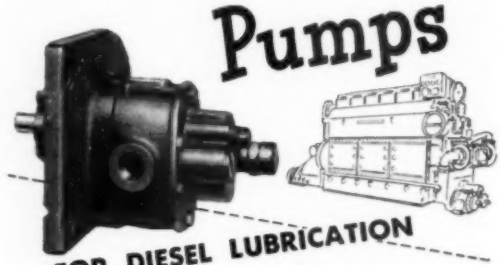


12 to 60 horsepower
2, 4 and 6 cylinders

HILL DIESEL

HILL DIESEL ENGINE CORP.
DIVISION OF DRAKE AMERICA CORPORATION
LANSING, MICH.

Pumps



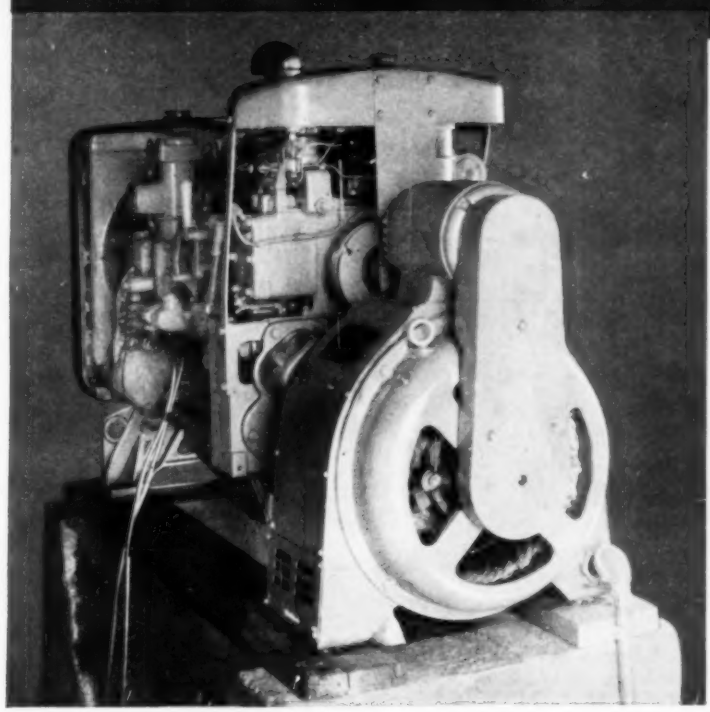
FOR DIESEL LUBRICATION

THE rotary geared pump shown above is particularly suited for diesel lubrication systems. It has a special flange mounting to facilitate installation together with provision for tachometer drive.
Thousands of Brown & Sharpe Pumps are now providing trouble-free service for transfer, lubrication and booster systems. Get acquainted with their reliability and economy. Write for Catalog. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

We urge buying through the Distributor

BROWN & SHARPE BS

"Sticking Rings Were Only A Part Of Our Problem"...



"Here's an example of what we're up against when we keep our high-speed diesels performing in heavy duty operation. It's clear from this picture that a number of compression rings are stuck in the grooves and the oil ring and oil holes are plugged."

"With another diesel engine operating under the same conditions but with the right type and grade of Cities Service heavy duty oil we got the results shown in this picture. The right oil did the trick."

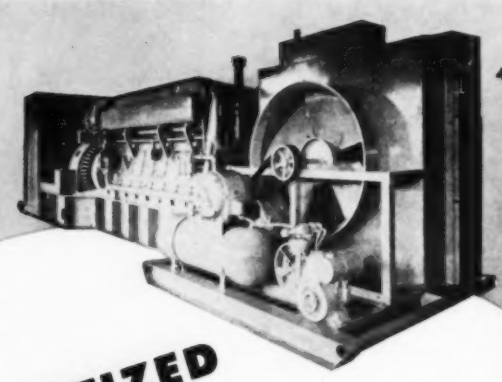
CITIES SERVICE HEAVY DUTY OILS

Cities Service Heavy Duty oils have an unmatched reputation for outstanding performance in diesel engines operating continuously under heavily loaded conditions. They assure:

- Very low carbon residue
- High oil stability
- High heat resistance
- High viscosity index
- High detergent-dispersant properties

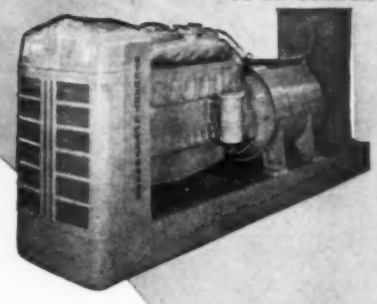
Free—Write today for our big 64 page booklet entitled "Diesel Engine Lubrication" Address Cities Service Oil Company, Room 479, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE



400 kw Portable Power Plant

75 kw Generator Set



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Portable Pumping Units

Complete Overhead Irrigation Systems

Whatever your power needs, whatever the application, Stewart & Stevenson can help you if you have a power problem.

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COMPLETE FACILITIES ALL UNDER ONE ROOF:

- Engineering
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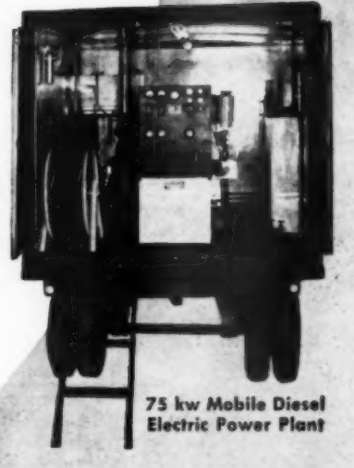
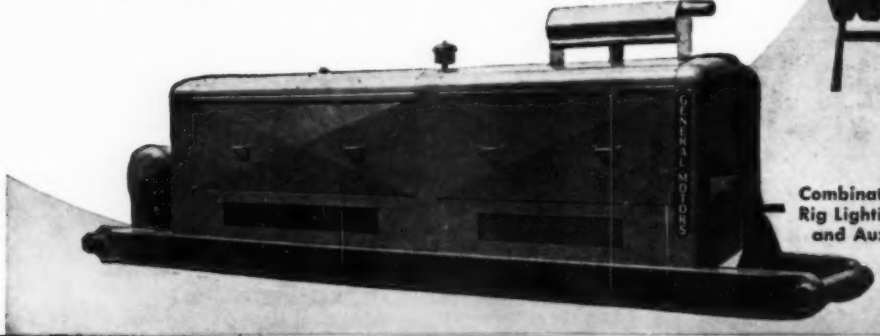
All units can be furnished with either diesel engines or gas, gasoline or butane engines.



75 kw Mobile Diesel Electric Power Plant

STEWART & STEVENSON SERVICES, Inc.

4516 HARRISBURG BLVD. • HOUSTON, TEXAS • PHONE W. 6-9691



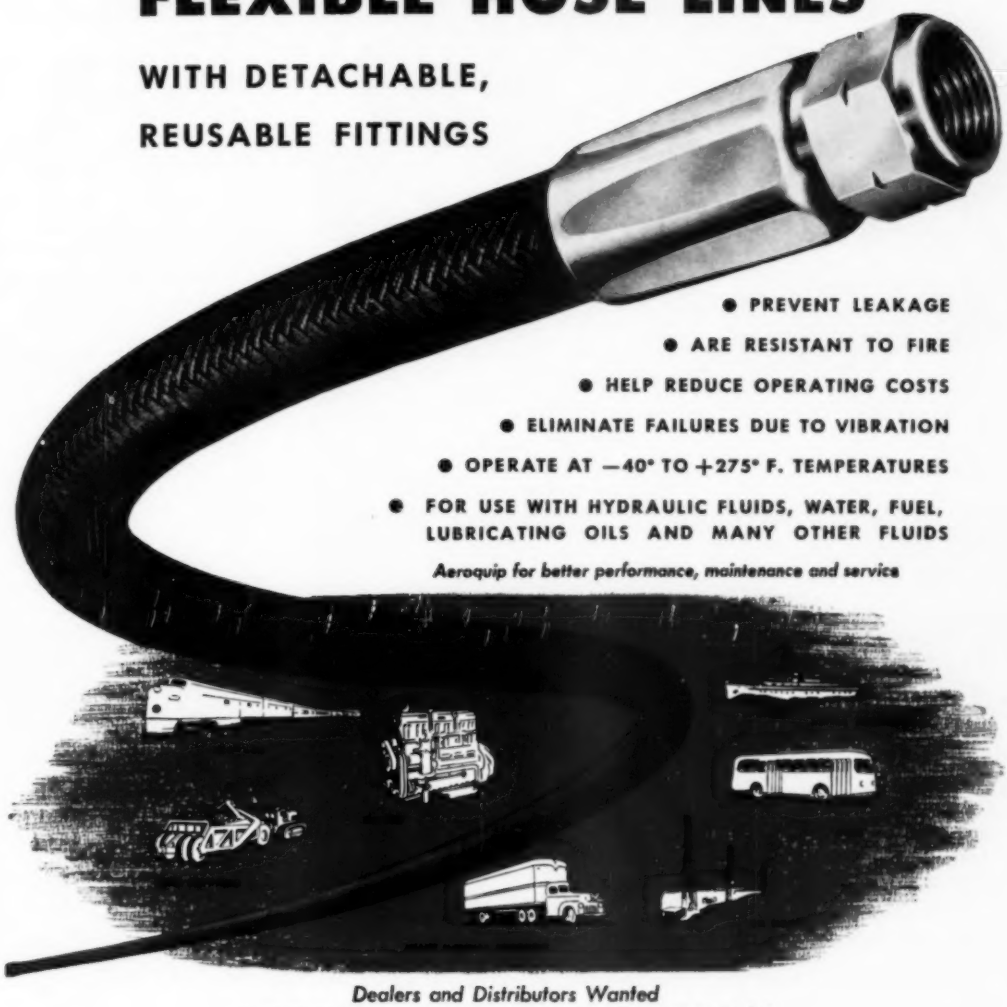
Combination Oil Field Rig Lighting, Welding and Auxiliary Unit

THE NATION'S LARGEST DISTRIBUTORS OF GM DIESEL ENGINES

Aeroquip

FLEXIBLE HOSE LINES

WITH DETACHABLE,
REUSABLE FITTINGS



- PREVENT LEAKAGE
- ARE RESISTANT TO FIRE
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- OPERATE AT —40° TO +275° F. TEMPERATURES
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Aeroquip for better performance, maintenance and service

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AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U. S. A. AND ABROAD

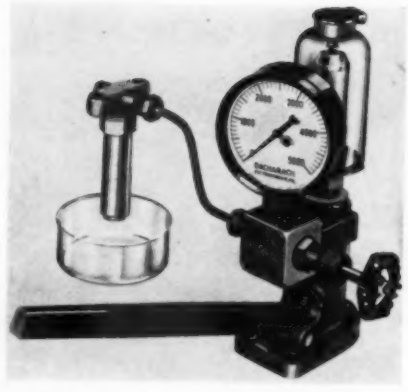
What They're Saying About the Railroads

"GOVERNMENT control of the roads would be just another step on the road to socialism which can only mean ultimate disaster for us all. Our railroads, financed and built by private capital, have a good record and it is only fair that investors should have an opportunity to earn a small profit on their investment."—Dr. George S. Benson, President, Harding College, Searcy, Ark.

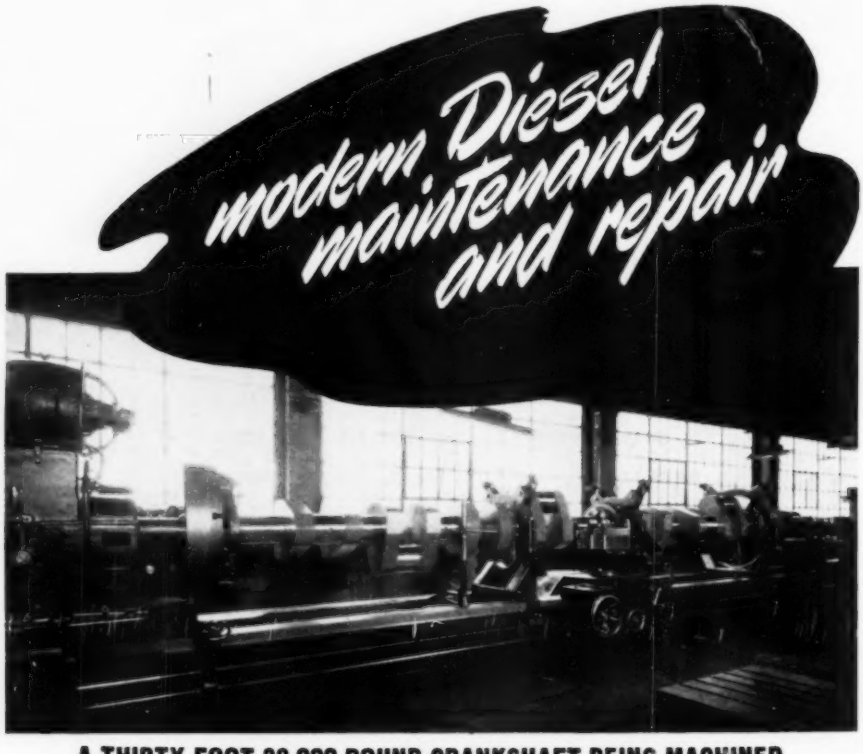
"The railroads of this country have a commendable record established in recent years for safety for their passengers and for safety among their employes. The railroads and their employes are safety-minded and their record in recent years proves the effectiveness of the doctrine of safety. Other means of transport would do well to be as mindful of safety as the railroads."—Spartanburg (S.C.) Herald.

"When it comes to mass transportation—the kind of transportation on which our industrial and agricultural economies rest—the iron horse is still supreme."—Clinton, Mass. Item.

Bacharach Company Takes Over ADECO Nozzle Tester



BACHARACH Industrial Instrument Company of Pittsburgh, Pa., has acquired all manufacturing assets and patent rights for the ADECO Nozzle Tester formerly manufactured by Aircraft and Diesel Equipment Corporation. This marks one more step in Bacharach's post-war expansion of its line of diesel testing instruments. The company reports that the tester is already in quantity production and available for immediate delivery. Bacharach also offers complete repair service for all ADECO Testers now in use. A complete line of nozzle connectors and fixtures has been developed to permit testing any make and type of diesel nozzle and injector unit. A steel carrying case has also been added to facilitate portable use of the tester. This carrying case is suitable for all ADECO Nozzle Testers now in use. For full particulars write Bacharach Industrial Instrument Company, 7000 Bennett Street, Pittsburgh 8, Pa.



A THIRTY-FOOT 28,000 POUND CRANKSHAFT BEING MACHINED

Our complete diesel repair facilities, developed over the last forty years, enable us to repair shafts of any size, regardless of the nature or location of the damage. Fractured sections are cut out, new forged sections are shrunk in place, then refinished in perfect alignment without reducing journal or crankpin diameters.

Our service includes experienced personnel available for "on location" inspection or work, or to recommend action. Our experience includes the ability and the equipment to handle any type of diesel repair or rebuilding.

IMMEDIATE ATTENTION given to trouble calls anywhere in the United States. Phone L.D. 84, wire or airmail.

"KEEPING PACE WITH DIESEL PROGRESS"

WASHINGTON IRON WORKS, INC.

Established 1876

SHERMAN, TEXAS

Trailer-Mounted Units For On-the-Job Operation

INTERNATIONAL Diesel Electric Company has announced production of a complete line of fully equipped and self-contained trailer-mounted electric generator sets in capacities ranging from 10 kw. to 85 kw. These units, specially designed for on-the-job operation, can be easily moved from location to location, making them ideal for road construction and maintenance, strip mining, bridge building, oil fields and construction camps.

Available in both diesel and gasoline, 50 and 60 cycles, and in all standard voltages, these generator sets consist of an engine driving a generator, with an instrument panel containing all starting controls and switchgear, spring-mounted on a sturdy, pneumatic-tired four-wheel trailer. The trailer is equipped with a steel angle drawbar for attaching to truck or tractor. Detailed specifications may be obtained from International Diesel Electric Co., Inc., 13-02 44th Avenue, Long Island City 1, N. Y.

8 outstanding N.B.M. BABBITTS

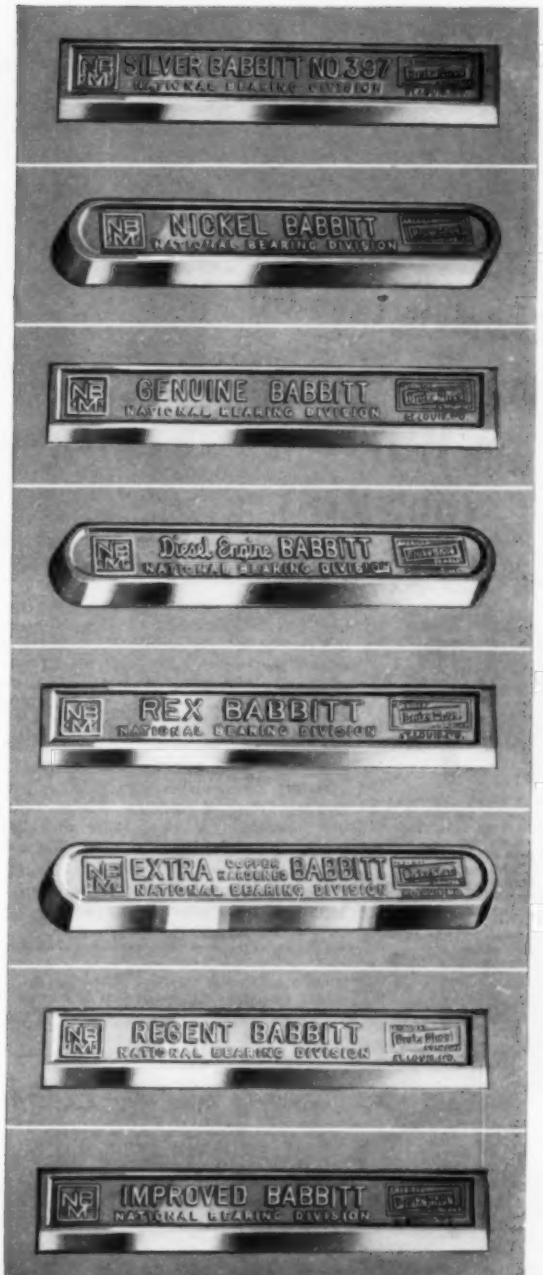
Help Give You Better Bearing Performance . . . Longer Bearing Life

Good babbitt is the result of using Virgin Metals, correctly proportioned and blended under close laboratory control. You find *all* these qualities in N-B-M Babbitts.

The 8 N-B-M Babbitt Metals shown are the result of years of research combined with actual engineering analysis of all types of bearing lining problems. Each of these N-B-M Babbitt Metals is "custom-alloyed" for specific types of service conditions. Thus, each has definite advantages over so-called "all-purpose" babbitts—advantages that result in longer, more economical bearing service.

These "Custom-Alloyed" bearing lining metals have effected important savings in plant maintenance—and big improvements in product performance. Every Product Designer or Plant Engineer should have engineering data on the complete line of these better N-B-M Babbitt Metals.

Here is Complete Data on N-B-M Babbitt Metals . . . This folder describes all 8 N-B-M Babbitt Metals, giving data on application, physical properties, preparation of bearing shells and pouring. Write for your free copy!



NBM

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

ST. LOUIS 10, MO. • MEADVILLE, PA.

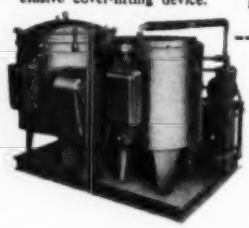
PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

Hoffman builds two series of cartridge filters. One employs Navy 7x18 throw-away units (see cut); the other uses 11x18 cartridges, either throwaway or repack-able. Both provide shunt or by-pass operation. Note ex-clusive cover-lifting device.

For its giant installation at Tacubaya, Nord-berg installed Hoffman cartridge filters to assure the clarity of lubricating oil. Pictured above is one of the twelve I-1118-6W units (two to each of the six Nordberg engines) which use 11x18 cartridges of the repackable type for either cellu-lose or fuller's earth.

Unique construction features, as well as de-pendable performance, have made Hoffman cartridge filters increasingly popular with engine builders. Ease of cartridge change and cleaning are provided by swing-bolts that fasten the head. Domed head and insulation avoid heat loss, maintain uniform efficiency.

Full particulars on the complete line of Hoffman filters available on request. Write now.



Also installed at Tacubaya, a Hoffman 50-100 g.p.h. Oil Conditioner. Cuts oil bills by reclaiming used oil to new standards. Re-moves both insolubles and solubles (air, water, fuel dilution, etc.). Needs no steam or water connections. Models from 50 to 600 g.p.h.

Write now for Bulletins

FILTRATION ENGINEERING SERVICE... For the right answer to your filtering problems, a Hoffman filtration engineer will survey your requirements and furnish recommendations based on de-tailed analysis of all factors. Ask for this service—There is no obligation.

HOFFMAN

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UNITED STATES HOFFMAN MACHINERY CORPORATION
212 LAMSON STREET, SYRACUSE 6, NEW YORK
CANADIAN PLANT: CANADIAN HOFFMAN MACHINERY CO., LTD., NEWMARKET, ONT.

Charles Hosmer Morse II Killed In Airplane Crash

CHARLES Hosmer Morse III, Vice Presi-dent in Charge of Manufactur-ing, Fairbanks, Morse & Co., Chicago manu-facturers, and eldest son of Colonel Robert H. Morse, Presi-dent of the Company, lost his life when the Company's big Lockheed Lodestar two motor plane crashed near Roanoke, Illinois, Saturday morning, July 9, 1949.

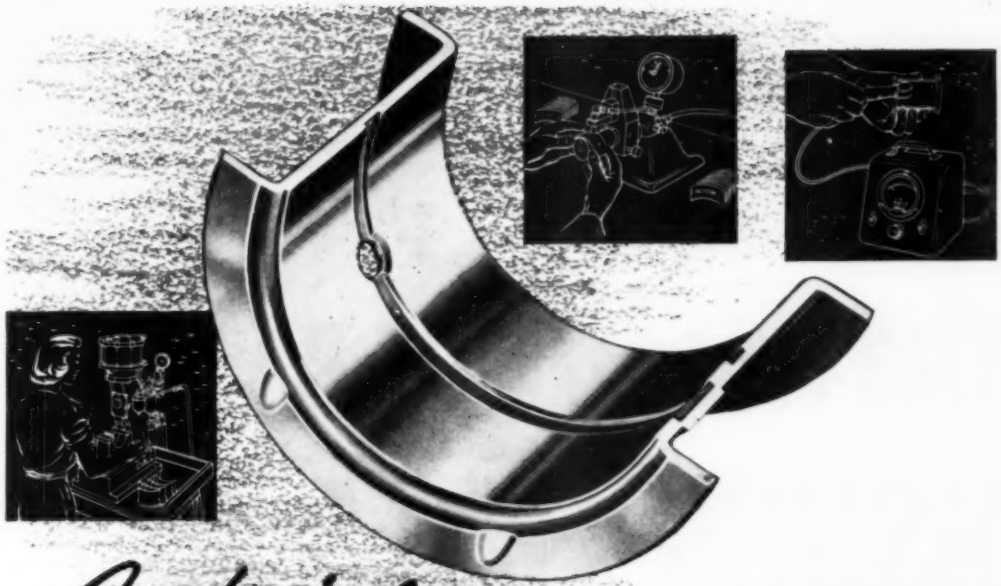
"Hos," as he was best known by his host of friends and business associates, had been con-nected with Fairbanks, Morse & Co. since 1919. He first worked at the Beloit plant. Honorably discharged as a wounded veteran of World War I he rejoined the organization and worked in the Company's factories at Three Rivers, Michi-gan, Indianapolis, Indiana, and St. Johnsbury, Vermont. Later he was assigned to Company branches in many parts of the United States. He was at one time Assistant General Manager of the Beloit Works. He left Beloit in 1939 to be-come President of the Inland Utilities Company, a Fairbanks-Morse affiliate. On June 21, 1946, he was elected Vice President in Charge of Manufac-turing, with headquarters at Chicago.

He is survived by his widow, daughter and two sons. He was a brother of R. H. Morse, Jr., Vice President in Charge of all Operations of the Co.

Henry W. Dodge Joins Mack

HENRY W. DODGE has joined Mack Trucks, Inc. as executive vice president with special re-sponsibility for sales and advertising, it is an-nounced by E. D. Bran-some, president and chairman of the board. Mr. Dodge, chairman of the board and director of Air Products, Inc., at the time of acceptance of his new position, was on loan to ECA as chief of petroleum on the staff of Ambassador W. Averell Harriman in Paris. He resigned both positions as of June 30th.

A veteran sales executive, Mr. Dodge was asso-ciated for many years with the Texas Company, in which organization he filled the posts of vice pres-ident and general sales manager. During the re-cent war he served for two years with the War Production Board and for over one year with the Petroleum Administration for War as director of the seventeen Eastern Seaboard states which com-prised PAW's District No. 1.



Combining PRODUCTION IN THE MILLIONS WITH QUALITY IN THE INDIVIDUAL BEARING

To assure top quality in mass production of sleeve bearings, at low cost, our Quality Control and Production Methods organization conducts as many as 108 separate tests for material quality and physical accuracy of the individual bearing. Specialists for almost 50 years, our six-plant organization is tailored to the peculiar needs of sleeve bearing production—from original research to field tests of the finished product. Our engineering department will gladly consult with you on your problems.

28 PRECISE MACHINE OPERATIONS

84 MEASUREMENT CHECKS

24 ADDITIONAL TESTS

are conducted on a strip-type, copper-lead lined, steel-backed flanged bearing.

HIGH SPEED, high temperature, automotive type bearings available in many combinations.

SPEED & LOAD bearings for pumps, compressors, industrial electric motors and similar uses.

HEAVY LOAD for big Diesels, power plants, etc.—bearings up to 27½" O.D., steel and bronze back.

BRONZE PARTS in many shapes, sizes; thrust washers, bushings; for many types of applications.

Power goes to work smoothly through

FEDERAL-MOGUL

FEDERAL-MOGUL CORPORATION — FEDERAL Mogul Silent SLEEVE BEARINGS — 11039 SHOEMAKER, DETROIT 13, MICH.

Diesel Locomotives on the Increase

A COMPARISON of the number of steam vs. diesel electric locomotives in service as of March 31, 1949 vs. 1944, released by the Bureau of Transport Economics and Statistics, I.C.C., shows 16.8 per cent of all locomotives are diesel-powered.

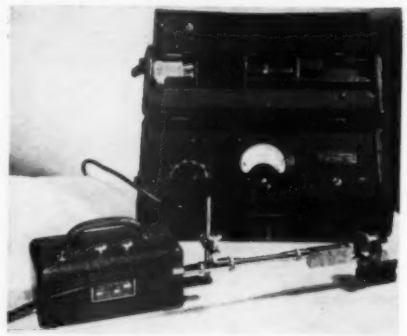
During this period steam locomotives declined by 7,963 units while diesels increased by 4,444 units. During the first half of 1949 the railroads placed in service 1,010 new locomotives of which 969 were diesels . . . 41 steam. More new locomotives were installed in the first six months of 1949 than in any corresponding period in approximately a quarter of a century.

Mo. Pac. Lines has placed 18 new diesels in service this year . . . 27 are on order . . when received later this year 209 will be in operation.

New Diesel Locomotives Ordered by Erie

THE Baldwin Locomotive Works has received orders from the Erie Railroad Company for one (1) 1000-hp. diesel-electric switching locomotive and six (6) 1500-hp. diesel-electric road switching locomotives; also an order from the Union Railroad Company for five (5) 1500-hp. heavy duty diesel-electric road switching locomotives, similar in design to seven Baldwin diesels which were delivered to this railroad early this year.

Instrument for Reading Surface Roughness



Type Q Profilometer with Type V Mototrace.

THE Profilometer is an exceptionally practical direct-reading instrument for the measuring of surface roughness in definite inch units. It will measure practically any machined or finished surface, external or internal, in any direction and for any desired distance. It has been developed as a "shop tool" for use in production departments even on parts still in the machine.

Conveniently portable and sturdily constructed, it is claimed that its simple operation can be quickly learned.

The basic operation is the moving of the "tracer" over the work and the observation of the reading on the microinch meter on the instrument panel. As more and more engineering departments specify microinch finishes, the designers of this instrument feel they are fulfilling a long-felt production department "want."

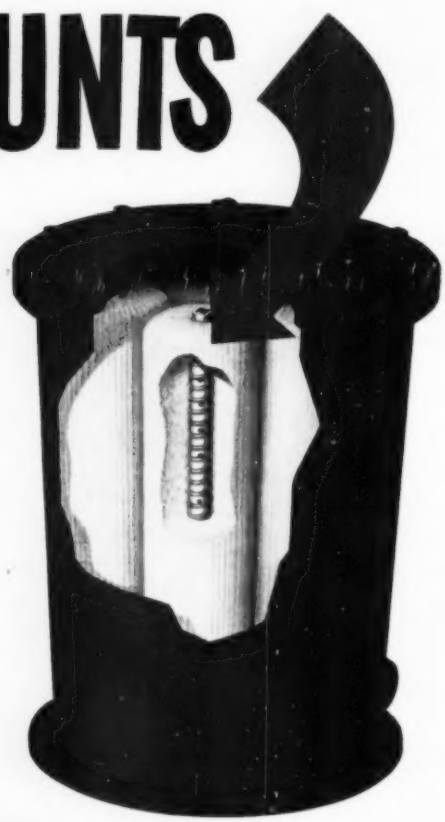
The surface of all materials finished by grinding, milling, turning, planing and other methods is composed of countless tiny irregularities and it is only in recent years that the degree of "finish" has been accurately measured. The Profilometer measures the roughness of the surface which together with waviness and flaws comprises the irregularities.

The "tracer" is in effect, an electric "pickup" which, as it is moved over the irregularities, converts these mechanical fluctuations into corresponding electrical ones. An amplifier in the Profilometer magnifies these until they are powerfull enough to actuate a meter and the reading thus produced represents the average surface roughness of the part being measured.

A complete line of standard tracers is available which permits measuring roughness of practically any machined part, a Stiffarm attachment being used for deep holes and other hard-to-reach surfaces. A Reading Recorder attachment is also available for making permanent chart records.

Full details are available on request from: Physicists Research Company, Ann Arbor, Michigan.

It's the INSIDE of a WINSLOW FILTER that COUNTS



Patented features are built into your Winslow Elements that assure complete protection of fuels and lubricants against moisture, acids, grit, sludge and other impurities. Over 200 Winslow Elements fit *any* make filter. Write for further details.

WINSLOW FILTERS

AD-4902

Winslow Engineering Company

4069 Hollis Street • Oakland 8, California

New Executives at Pesco Products

D. A. Sutherland John A. Lauck

Additions to the executive personnel of the Pesco Products Division of Borg-Warner Corp. have been announced as the division pushes its new production plant and research laboratory in northeastern Bedford Township near Cleveland, toward completion. The naming of John A. Lauck as Vice President topped a list of new appointments given out by R. J. Minshall, President of Pesco. Mr. Lauck, who has been chief engineer of Pesco's pump division for the last four years, will assume his new post immediately, several months before the scheduled start of operations in the company's new $2,650,000 plant.

Appointment of D. A. Sutherland, formerly Pesco's Eastern Sales Manager for Industrial Products, as Industrial Relations Manager also was announced. Mr. Sutherland at one time served as field engineer in charge of sales and sales promotion for the B-W Supercharger Division of Borg-Warner and earlier was power engineer and sales engineer for Fairbanks-Morse and Co. Mr. Sutherland will be succeeded in his previous sales managerial position with Pesco by G. V. Patrick, formerly Executive Vice President of the Cleveland Automatic Machine Co.

Another appointment was that of Frank R. Canney as Sales Engineer in charge of Pesco's sales activities with the airline companies. Most of Mr. Canney's broad background in aircraft engineering was acquired during 25 years with the Boeing Airplane Co.

Pesco's entire manufacturing and research equipment is to be moved from the company's present location at 11610 Euclid Ave., Cleveland, to the new 35-acre site in Bedford Township. General expansion in the aircraft and other manufacturing fields dictated the need for an efficient new production plant, company officials said.

A. J. Rinnander Joins Harnischfeger

MR. A. J. RINNANDER, formerly with the Chicago Pneumatic Tool Company, New York, has become a member of Harnischfeger Corporation, Milwaukee. Mr. F. Salditt, Vice-president in charge of sales, makes the announcement, stating that Mr. Rinnander will supervise field activities, Zip-Lift Hoist distributors and sales on a national basis under the direction of Mr. E. W. Potrarz, Manager Hoist & Trav-Lift Crane Division, Milwaukee.

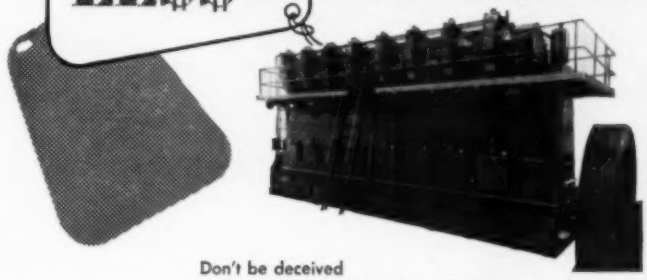
New G.M. Diesel Distributor

DIESEL Equipment Co. of Wichita have been appointed exclusive distributors for General Motors Series 71 diesel engines in central and western Kansas. The franchise covers industrial and petroleum engine sales as well as service in those counties west of and including Washington, Clay, Dickinson, Morris, Chose, Greenwood, Elk and Chautauqua.

Organized just this past winter for the express purpose of marketing GM diesel engines, Diesel Equipment Company is marked by capable leadership and extremely fine operating facilities. James D. Jarvis, president of the company, has been a well known figure in Kansas financial circles for many years. Engine sales are under the direction of Andrew C. Cartwright whose broad background in the diesel industry extends over a period of 17 years. Complete sales, service and parts operations are quartered in a modern 130 x 150 foot building designed to efficiently handle all phases of diesel engine work. The plant is accessibly located on U. S. Highway 81 one mile north of the center of town.

FULTON DIESELS COST

LE$$ PER YEAR OF SERVICE!



Don't be deceived by "barguin" Diesel prices. Skimping on size and stamina, depending on speed for power, is bound to boost operating and upkeep costs — wear the engine to premature death.

Massive, low-speed FULTONS give remarkable fuel economy: 14.30 K. W. per gallon at 100% load. Oversize, precision parts make maintenance negligible. And even we don't know how long they'll last — the first ones we built in 1914 are still going strong!

• MAY WE SEND YOU NEW ENGINEERING DATA on latest FULTON advancements including dual-fuel? TYPE KS: 6 or 8 cylinders—1840 to 4000 HP at 240 to 257 RPM. TYPE BGS: 5, 6, 7 or 8 cylinders—750 to 1980 HP at 257 to 277 RPM.

FULTON DIESELS — your best buy in the long run

FULTON IRON WORKS COMPANY
SAINT LOUIS 14, MISSOURI
New York Office: 82 Wall Street, New York 5

Baldwin President Reports on Sales

MR. M. W. SMITH, President of The Baldwin Locomotive Works, reported that consolidated sales of the Company and its wholly owned subsidiaries for the six months ended June 30, 1949, were $68,032,019 and that net profit for the period amounted to $1,829,627 as compared with sales of $61,711,160 and net profit of $1,618,118 for the six months ended June 30, 1948. No dividends were received from The Midvale Company during the six months ended June 30, 1949, as compared with dividends of $383,425 received from Midvale during the six months ended June 30, 1948.

After provision for preferred stock dividends the remainder of net profit for the six months ended June 30, 1949, was equivalent to 74c per share on the 2,375,553 shares of common stock outstanding at June 30, 1949 as compared with 82c per share for the six months ended June 30, 1948, on the 1,875,553 shares of common stock outstanding at June 30, 1948.

Mr. Smith further reported that orders booked during the six months ended June 30, 1949 amounted to $31,323,193 and that orders unfilled as of June 30, 1949 amounted to $68,010,049 as compared with orders booked during the six months ended June 30, 1948, amounting to $68,211,601, and orders unfilled as of June 30, 1948, amounting to $122,571,569.

Power failure can be a costly inconvenience in dollars, and even lives. The instant the main power fails, a SYNCHRO-START equipped standby generator set will go to work and get the generator on the line to provide emergency power. With most small engines, the plant will be on the line producing emergency power in five seconds or less—larger engines in proportion.

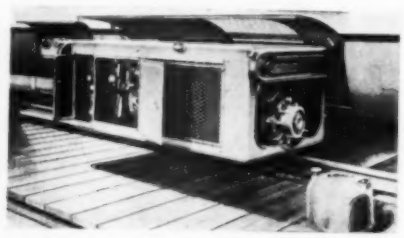
The proper SYNCHRO-START automatic controls can be furnished for any model of internal combustion engine. In addition to power failure starting, they are used for fire protection, water and sewerage pumping, underpass pumping, mine ventilation, industrial processing, refrigeration, television, telephone, radio, etc.

Write for full information or contact your engine dealer or manufacturer.

SYNCHRO-START PRODUCTS, INC.
Automatic Engine Control Equipment

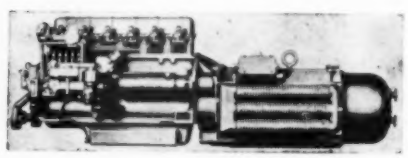
Waukesha "Enginators"

THE Railway Division of Waukesha Motor Company has issued a new and interesting bulletin, No. 1496 giving a complete description of their new diesel-electric unit to be employed for furnishing electric power (other than for propulsion) on railway passenger cars.



Waukesha 25-kw Enginator withdrawn for inspection.

Waukesha has supplied engine driven generator and air conditioning equipment to many of the major railroads since 1936 and a number of crack trains have been equipped but it is only in the last six months that a 25-kilowatt diesel driven unit has been adopted.



Enginator removed from chassis showing AC engine governor and alternator. Note spiral heat exchanger tubes at side of alternator for generator closed circuit air cooling.

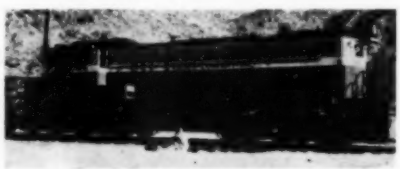
Waukesha has given these units the name of diesel "Enginators" and they are available as follows: 12.25-kw, 40-volt, 80-volt and 140-volt DC and 25-kw (31.25-kva), 240-volt, 60-cycle, 3-phase, AC. The bulletin may be obtained on request from Waukesha Motor Company, Waukesha, Wisconsin.

Tractors at Garrison Dam

SIX of the scores of Allis-Chalmers HD-19 Tractors working on the Garrison Dam recently teamed up to move in place this giant Bucyrus-Erie shovel. The 400,000 pound unit is one of three the Peter-Kiewit-Morrison and Knudsen firm has working on river embankments. The equipment is working in a great bend in the Missouri River, 75 miles northwest of Bismarck, North Dakota. Powerful HD-19 Torque Converter tractors, huge 6 cubic yard shovels, Euclid wagons, and other forms of modern construction power are working to move 67,000,000 cubic yards of dirt which will go into Garrison Dam, destined to be the world's largest rolled-earth filled dam.

Second Baldwin Diesel-Electric on Western Railroad

THE Eagle Mountain Railroad of California, the only private standard-gauge railroad built in this country since 1926, and the longest since 1918, received its second Baldwin 1500-hp diesel-electric locomotive early in August, The Baldwin Locomotive Works, Philadelphia, Pa., has announced. Less than a year old, the 52-mile road now operates a total of two locomotives, both of them Baldwin 1500-hp roadswitchers, to haul ore from the Eagle Mountain mine to the Henry J. Kaiser steel plant at Fontana, California.



Built and owned by the Kaiser interests, the desert railroad connects the Eagle Mountain mine with the Southern Pacific main line at Ferrum, Cal., on the Salton Sea, 191 feet below sea level. In the 52 miles between the terminals, the road passes through sandy wastes, climbs to a summit of 1,658 feet, bridges a canal, and spans a creek on a 550-ft trestle. The locality around the mine has been called "The Mesabi of the West." It has been estimated that the open pit mining operations there will yield a proved 25,000,000 tons of 54 per cent iron ore. The 164-mile rail movement between Eagle Mountain and Fontana provides the Kaiser plant with one of the shortest hauls for its iron ore of any large steel plant in the U. S.

Baldwin 1500-hp diesel locomotives were chosen for the heavy-duty ore hauling job on the recommendation of Kaiser Engineers, Inc., a separate organization which passes on all matters concerning engineering problems of Kaiser enterprises. Work was started on the Eagle Mountain Railroad in July, 1947. The line was completed eleven months later and was put into full operation in November, 1948. Total construction cost was $3,800,000.

The Baldwin 1500-hp diesel-electric locomotive has two six-wheel, rigid bolster trucks equipped with 42-in. wheels. Its six traction motors develop a high tractive effort of 64,200 lbs. at 6.6 mph. Each locomotive is fitted with a dynamic braking system in addition to the standard air brake equipment, holding the heavily-loaded ore trains at best and safest operating speeds while descending a 20-mile 2 per cent grade and a shorter 2.15 per cent grade. The power unit which furnishes current to the traction motors is a Baldwin model 608-SC (supercharged) vertical four-cycle, eight cylinder-in-line diesel engine. It is coupled directly to a Westinghouse direct-current generator which is separately excited from the belt-driven exciter generator.

In construction of the Eagle Mountain Railroad special consideration was given to provide drainage and protection adequate to handle the cloudbursts that occur frequently in the area. A bridge spanning a stream known as Salt Creek had to be designed to carry 20,000 cubic feet of water per second.

Kohler Engine Primer

KOHLER CO., Kohler, Wisconsin, has developed an Engine Primer for Diesel engines which operates with "Chevron Starting Fluid" as well as with gasoline, oils and other fluids. The inlet and outlet connections of Kohler Engine Primers are machined to user specifications and the capacity adjusted to equal any installation requirement.

It is claimed this engine primer guarantees 100% displacements with each stroke to insure a steady, even flow on 1/8" or 3/16" priming lines. Handle leakage is prevented by positioning two "O" rings, which are impervious to starting fluids, on the piston. Carefully machined seat and seating pin on the tip of the piston, controls the possibility of flooding by preventing fuel seepage. The ball checks incorporated in the body, open and close alternately with each piston stroke, preventing fuel flow when the piston is not active.

Kohler Engine Primers are being specified on air heater starting or "quick" starting systems by major manufacturers of diesel engines.

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This superior lubricant has unusually high resistance to heat, oxidation, sludge formation and corrosion. It has a higher viscosity index. *It stands up!*

That's why more and more operators of heavy duty Diesels are specifying D-X Diesel Motor Oil. They depend on D-X to keep their Diesels running with a minimum of shut-down time. Mail the coupon below today for complete information about D-X Diesel Motor Oil.

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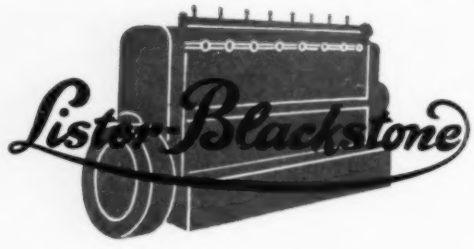
Electro-Motive Announces Reduction in Repair Costs

ELECTRO-MOTIVE Division of General Motors Corporation has announced in a recent parts and stores bulletin that prices covering motor overhaul have been substantially reduced. The reasons given can be attributed to previously announced reductions in many parts prices plus expanded factory repair service facilities. The bulletin cites, as examples, comparisons between present low figures and the flat-rate price schedules used heretofore.

The present price reductions center around the traction motor overhaul or the armature overhaul. The bulletin reveals that these two basic jobs can now be had for prices of $276 and $56 respectively. Thus traction motor or armature overhaul, requiring nothing more than the basic work, can be given a factory guaranteed job for a new low cost to the customer. This phase of the change alone will be of particular interest to many railroads who make a practice of returning motors to LaGrange or Electro-Motive's outlying branches for overhaul at regular prescribed mileage intervals.

In addition the new bulletin "spells out" any "extras" with a clear description of the work to be done, itemizing the operation by repair reference numbers and providing price break-down for labor as well as material costs. These figures, too, reflect additional savings wherever parts price reductions and improved facilities make them possible.

"The Diesels That ENDURE"



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In suitable engine types and horsepower ranges to meet the ramified requirements of main-engine installations for:

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Fishing Vessels, Towboats, Harbor Work Boats, Ferries

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INCORPORATED

Factory, Sales and Service Headquarters:
420 Lexington Avenue, New York 17, N. Y.

Parts Warehouses: MILWAUKEE, Wis., 3073 S. Chase Street
BOSTON, Mass., Whesco Building, Fish Pier

Agents: BOSTON, Diesel Engine Sales & Engineering Corp.; NEW YORK, Griffin Equipment Corp.; NORFOLK, Va., Curtis Marine Co.; NEW ORLEANS, La., (Branches at MOBILE, Ala. and TAMPA, Fla.), Calmes Engineering Co.; MIAMI, Florida, Auto-Marine Engineers; HOUSTON, Texas, Southern Engine & Pump Co.; NEWTON, Iowa, Winpower Manufacturing Co.; MONTREAL and TORONTO, Consolidated Engines & Machinery Co., Ltd.; WINNIPEG, Mumford, Medland, Ltd.; VANCOUVER, B. C., Hoffars, Ltd.; ST. JOHNS, Newfoundland, Clayton Construction Co.

New Assistant To Vice President For American Locomotive

APPOINTMENT of Charles C. Davis as Assistant to Vice-President—Western Regional Sales of American Locomotive Company was announced by W. E. Corrigan, Vice President—Sales. Mr. Davis, formerly sales representative at St. Louis, will be located at the company's Chicago office. Appointment of Carl A. Gandy, Jr., as sales representative at St. Louis also was announced. Mr. Gandy formerly was sales representative at Atlanta, Ga.

Mr. Davis, a graduate of St. Bonaventure College, has been with American Locomotive Company since 1940. He spent a year at the Auburn, N. Y. plant and was transferred to Schenectady in 1941. He was located here until 1946 as service engineer and sales representative except for three years' service as a Captain in the Army Transportation Corps. Mr. Davis went to St. Louis in 1946.

Mr. Gandy graduated from Louisiana State University and the Hemphill Diesel School at Memphis, Tenn. Three years after joining Alco at Auburn in 1940, he became a service engineer with the company. In 1948, he was transferred to Atlanta as sales representative.

Price Reductions—Lubricators

PRICE reductions of 5 per cent on Manzel automatic lubricators and chemical feeders, effective immediately, were announced today by Herbert H. Roosa, vice-president of Manzel, Inc. The reductions were made possible, despite somewhat lower sales totals in recent months, said Mr. Roosa, as a result of increased manufacturing efficiency coupled with some reductions in raw material costs. The company likewise feels that reductions are in tune with the times and should possibly act as a sales stimulant.

The Manzel company is also endeavoring to improve its sales levels by developing new uses for its lubricators and feeders in addition to the long established markets in the steam and diesel power fields and in the field of chemical processing.

Railroad Debt Declines

A REDUCTION of 14.4 per cent in the long-term debt of the railroads was made during the 1943-1948 period, according to the Bureau of Transport Economics and Statistics, I.C.C. "Long-term debt" refers to bonds issued for capital purposes and to certificates issued to finance the purchase of locomotives and cars.

The extent of the decline in bonded indebtedness is especially significant when it is realized that the overall long-term debt declined 14.4 per cent while the equipment obligations advanced 86.3 per cent because of the huge purchases of locomotives, freight cars and streamlined trains during and following the war. Interest accrued on the debt shows a decline of 28.8 per cent, 1948 vs. 1943.

Nordberg Appoints New Southeastern Representative

F. O. Walsh, Jr.

THE appointment of Frank O. Walsh Jr. as a sales representative of the Heavy Machinery Division in the Southeastern Territory is announced by R. W. Bayerlein, Vice-president of Nordberg Manufacturing Co., Milwaukee, Wis. Mr. Walsh has offices in the Volunteer Bldg., Atlanta, Georgia. He succeeds B. C. Fennell who recently elected to retire as Nordberg District Manager of the Southeastern Territory under the company retirement plan.

Mr. Walsh is a graduate of Georgia Tech and Cornell University. His diesel engine experience, most of which was obtained in the Southeastern states, includes ten years with the former McIntosh & Seymour Division of American Locomotive Company, a year with De LaVergne Engine Company and a year with Busch-Sulzer Bros. Diesel Engine Company, just prior to its merger with Nordberg.

He has four years World War II army experience and left the service with the rank of Lt. Colonel, Ordnance Dept. He was on duty at the Evansville Ordnance Plant and Franklin Arsenal and later with the Chicago Ordnance District, Army Service Forces, heading up all tank-automotive procurement and inspection activities.

Mr. Walsh, a registered professional engineer, is a member of the A.S.M.E., the Georgia Engineering Society, and is a Lt. Colonel, Ordnance, in the Organized Reserve Corps.

Federal-Mogul Acquires National Formetal

H. GRAY MUZZY, president of Federal-Mogul Corporation, Detroit, manufacturers of automotive engine bearings, today announced acquisition of National Formetal Company of Cleveland, Ohio, manufacturers of rolled split bushings since 1919. Federal-Mogul is one of the largest manufacturers of bearings in the world.

National Formetal Company manufactures rolled split bushings, bearings, spacers and washers used in automotive, appliance, wheeled toy and many other industries.

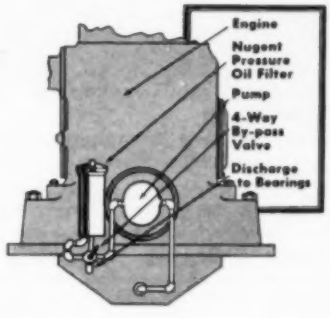
The company will be operated as a division of Federal-Mogul Corporation.

No change in personnel is contemplated. Robert Morris, former president of National Formetal, will remain as the division general manager and Benjamin S. Gerson, likewise a former officer, continues as sales manager. Arthur E. DeKome, a recognized specialist in the bushing field, remains as works manager and in charge of engineering. He has been instrumental in developing products and specialized manufacturing machinery. A. J. Jacobsen continues as assistant to the general manager, at the Cleveland Plant. Sales representatives throughout the country will generally remain in their present positions.

NUGENT large-capacity filters

. . . Filter ALL THE OIL EVERY CYCLE BEFORE it goes to the bearings

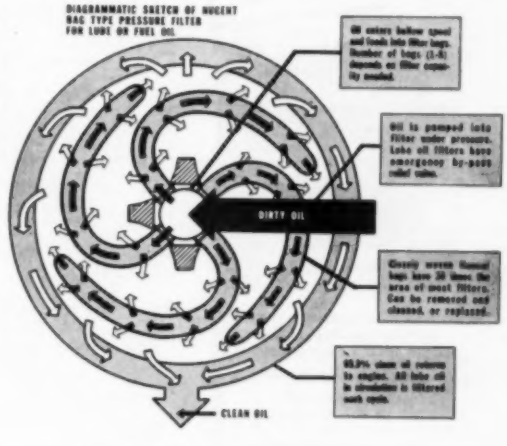
Nugent bag-type lube and fuel oil filters remove contaminants and dirt *as soon as they get into the oil and none is by-passed* to the bearings. IT'S THE OIL YOU BY-PASS THAT DOES THE DAMAGE. That the by-pass partial filter is outmoded and dangerous when used alone is proved by actual field tests, wherein bearing renewals showed a decided drop after the adoption of Nugent *full flow filtering.*



Further, Nugent bag-type lube and fuel oil filters with expendable bags have 20 times more filtering area than other filters of comparable size. Using a Nugent filter, you'll be able to clean more oil per hour, with fewer changes of filter elements. This is particularly important in full-flow systems, where all the oil in circulation each cycle is being cleaned.

The illustration at the left shows a Nugent full-flow filtering system. Note that the oil is handled by the engine oil pump—no other pump is needed. Filtering systems of this kind are ready for power equipment of any size. Ask a Nugent engineer to give you full details.

The diagrammatic view below shows the tremendous filtering surface of a Nugent bag-type pressure filter. The bag, designed to be used and discarded, is made of a closely woven lintless material which removes particles as small as a few microns and delivers oil 99.8 per cent clean. This type of filter is ideal for filtering all the lube oil in circulation every cycle before the oil goes to the bearings, thereby removing the dirt as soon as it gets in the oil, and retarding the formation of sludge and acidity. The dirt-filled bags are easily removed without tools, and are inexpensively replaced.



There's a bulletin giving complete information on Nugent bag-type filters. Write for your copy today.

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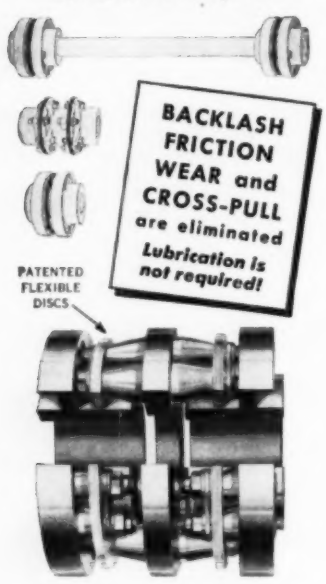

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ALL PARTS ARE SOLIDLY BOLTED TOGETHER.

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Start Made on General Motors Technical Center

EXCAVATION for the General Motors Technical Center began Monday on the 320-acre site at Mound and Twelve-Mile roads north of Detroit. The work was started on the Engineering Group buildings which are expected to be ready for occupancy by the late summer of 1950, according to William J. Davidson, administrative engineer of the Technical Center.

Later this summer excavation for the Research Laboratories Group of buildings will begin. The Technical Center will include the research, engineering staff, process and styling operations of General Motors. Project architects are Saarinen-Saarinen and Associates, Bloomfield Hills, Mich., and the architect-engineers are Smith, Hinchman & Grylls, Inc., Detroit. The construction contract was awarded to Bryant & Detwiler Company, Detroit, Michigan.

Financing Diesel Locomotive Purchases

DIESEL locomotives delivered during 1948 and the first part of 1949, were among the equipment listed by the Louisiana and Arkansas Railroad in applying to the Interstate Commerce Commission to assume liability for equipment trust certificates to refinance balances due under conditional sales contracts. These locomotives are as follows:

10. Electro-Motive Switchers, 1000-hp each.
2. Electro-Motive Freight Locomotives, each comprised of four 1500-hp units.
1. Electro-Motive Passenger Locomotive comprising two 1500-hp units.
2. Fairbank-Morse All-purpose Locomotives of 1500-hp each.
1. Electro-Motive Passenger Locomotive of 1500-horsepower.

Diesel Marine Panel October 20

FOR the past two years the Diesel Engine Manufacturers Association has cooperated with the American Merchant Marine Conference in presenting a Diesel Panel at their annual meeting, and has agreed to stage one this year on the morning of Thursday, October 20. The meeting will be at the Waldorf-Astoria Hotel in New York. Two speakers have already agreed to take part in this program: Poul A. Christensen, of Burmeister & Wain, whose subject will be "What Is Being Done in Europe with Diesel Engines in Cargo Vessels?" Capt. F. C. L. Dettmann, of the U. S. Navy, whose subject will be "The Use of Diesel Engines by the Navy." Other speakers will be announced later.

Vice-President of Hallett Returns From South America

W. D. Brumbach

MR. William D. Brumbach, Vice President in Charge of Sales of the Hallett Manufacturing Company, has just returned from an extensive three month business trip through Central and South America and the Caribbean area. He visited Hallet distributors and discussed marketing problems and future sales potentials. According to Mr. Brumbach, the dollar situation is deteriorating in most of Latin America, except for certain Caribbean areas and Venezuela, who still have dollars available for American goods. He stated that in his opinion, American manufacturers with strong distributor organizations were going to survive the temporary lull in the export field due to dollar shortages, but he stresses that European competition is greatly increasing and European manufacturers are offering liberal credit, early deliveries and competitive prices. Further, he stated that sterling was readily available to pay for British machinery.

Mr. Brumbach further stated that a factor of prime importance to manufacturers doing business in Latin America, such as the Hallett Manufacturing Company, is to have strong distributors who effectively know how to sell and thoroughly understand the importance of adequate parts and service shops. It is Mr. Brumbach's opinion that Latin American buyers in general prefer American diesel engines because of their advanced engineering, design, superior materials, and widespread availability of parts and service.

Standby Power Plants

THE Kato Engineering Company of Mankato, Minnesota, offers standby power plants with 1, 2, and 4 cylinder air-cooled engines that are ideal for standby power because there is no radiator and cooling solutions so that they can be installed in freezing atmospheres. They are equipped with high tension magnetos permitting easy hand cranking which eliminates need for starting batteries and their care. However, all models are available with electric cranking upon specification.

The A.C. generators are large in proportion to rated horsepower to facilitate starting single phase A.C. motors which require as much as five times running current for starting. They are available with or without automatic voltage regulator.

Engineering Societies Meetings Schedule

S.A.E. National Meetings

Tractor Meeting	Hotel Schroeder	Milwaukee, Wis.	Sept. 13-15
Aeronautic Meeting and Aircraft Engineering Display	The Biltmore Hotel	Los Angeles	Oct. 5-8
Diesel Engine Meeting	Chase Hotel	St. Louis, Mo.	Nov. 1-2

A.S.M.E. National Meetings

Fall Meeting	Lawrence Hotel	Erie, Pa.	Sept. 28-30
Annual Meeting	Hotel Statler	New York, N. Y.	Nov. 27-Dec. 2

Fairbanks-Morse Changes

FAIRBANKS, Morse & Co. announce that T. M. Robie, who has for the past several years been manager of the company's Diesel Division with headquarters in Chicago, has now been appointed Director of Quality Control for the firm's Beloit Works in Beloit, Wisconsin. He has been succeeded by J. W. Wright who more recently was manager of the company's Diesel Engine Sales Department at the Kansas City Branch.

T. M. Robie J. W. Wright

Both Mr. Robie and Mr. Wright are well known in the diesel engine field. Mr. Robie is a graduate in mechanical engineering from the University of Michigan. Following his service in World War I he joined Fairbanks, Morse & Co. in 1919 and has been with that company since that time in various capacities in manufacturing, service, and sales in Beloit, Wisconsin, Dallas, Texas, New York, New York, and Chicago, Illinois.

J. W. Wright is a graduate of the University of Kansas. After a brief period of employment in the Beloit Works of the company he became associated in sales for the company's Cleveland, Ohio, and Buffalo sales offices. Later he joined the Kansas City organization as a field engineer. From 1938 to 1942 he was Diesel Department Manager for the Dalas Branch of the company. Voluntering in the Navy in 1942 he was released from active duty in February 1946 with the rank of Commander U.S.N.R. He became manager of the company's Diesel Engine Department, Kansas City Branch, in March 1946 which position he held up to April 1st of this year.

New Diesel-engined Busses

THE new Beck Silverliner, powered with a 165 hp Model HRB-600 Cummins Diesel, first of a group of six such 37-passenger inter-city buses placed in service by Queen City Coach Company, Charlotte, N. C., was recently delivered.

Operating more than 375 pieces of automotive equipment, Queen City Coach Company is one of the largest independent bus operators in the United States. Previously this company used only gasoline engines, and the operation of the Cummins Diesel-powered Silverliners is being watched with interest by the bus industry.

Cracked Diesel Head

rebuilt as sound as new according to factory specifications . . . at a major saving to you

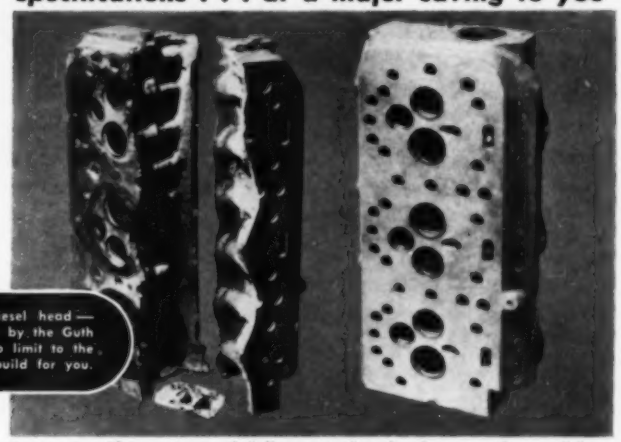


Photo shows the same Diesel head — before and after rebuilding by the Guth Fusion Process. There is no limit to the size of casting we can rebuild for you.

The Guth Fusion Process is a scientific system of fully restoring broken castings of iron or aluminum to as good as new. Developed in 32 years of experience, it cannot be compared with common "Fix-It" repairs. We serve some of America's largest firms. Every job is guaranteed to give you absolute satisfaction.

Use our Immediate Shipment Exchange Service on all popular makes of Diesel heads to get your equipment back to work quickly. Ship us your cracked head for a guaranteed replacement. Write now for your free copy of our catalog.

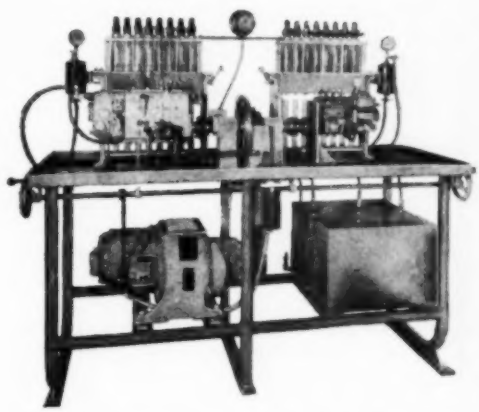
GUTH COMPANY
McPHERSON, KANSAS

SERVING THE NATION FROM ITS CENTER . . .

PIONEERS IN DIESEL TESTING EQUIPMENT

"Our AP Test Stand Has Paid For Itself Many Times . . ."

Says one user



Model AP 947 Diesel Fuel Injection Pump Test Stands. Several other models are available in various price ranges to suit individual needs.

- Assures equal delivery of fuel to all cylinders.
- Variable speed drive — equipped with tachometer and stroke counter — duplicates actual engine conditions and makes possible proper governor settings at idle as well as full load.
- Necessary gauges provided to check transfer pump pressure as well as vacuum and head pressure in case of Cummins pumps.
- Self contained—including fuel reservoir, supply pump and filters.
- Extra heavy steel table assures permanent alignment for pump drives.

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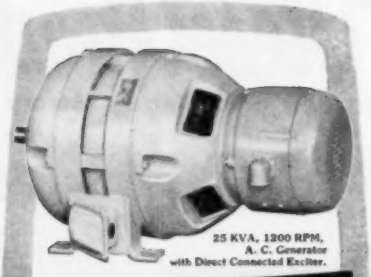

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A.C. and D.C.

Columbia, with its years of experience, brings to you a wide line of performance proved, sturdily built, A.C. and D.C. Generators. **A.C. Generators: 6¼ to 375 KVA. D.C. Generators and Exciters: 2 to 200 KW.** Available in Single or Two Bearing Construction. *Write today for information. Our engineers will be glad to review your requirements. Prompt delivery.*

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FREE MANUAL SHOWS
7 Ways to Speed up Diesel Cleaning

1. De-scaling Diesel cooling systems
2. Cleaning lube oil and jacket water coolers
3. Degreasing parts before repair and overhaul
4. Reconditioning Diesel air-intake filters
5. Cleaning intercooler of air compressors
6. Keeping painted equipment clean, shining
7. Cleaning Diesel crankcases

FREE Manual describes these and 64 other maintenance-cleaning jobs. Contains many effort-saving tips for removing scale, rust, sludge, oil, grease and similar deposits. They're all in the "Oakite 71 Digest." Send for your FREE copy today.

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Unique New Ship Design

RETIRED speedboat king Gar Wood reveals that he has designed and built a high-speed ship which he believes is the prototype of the express passenger liner of the future. The craft which he has named "Venturi," is unique in the fact of having twin hulls. Wood says that tests have proved the vessel extremely stable and fast, the twin hulls, unlike conventional hulls which climb up and over the waves, slice through the seas.

Gar Wood claims that tests on the 188 foot by 40 foot vessel, indicate that a 16000-ton ship of the same design would be able to carry 4000 passengers at the high speed of 38 knots.

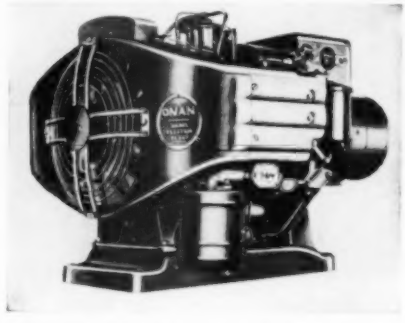
Powered by four 1200-hp G.M. pancake diesels, two in the port engine room and two in the starboard, the "Venturi" has a cruising range of 3000 miles. Illustrations show the stern view of the vessel and the port engine room looking forward.

New, Air-Cooled 5kw Diesel Electric Plant

A RADICALLY new, 5000-watt AC diesel electric plant is announced by D. W. Onan & Sons, Inc. The model 5DRP is said to combine unusually smooth operation and compact design and to produce surprisingly low-cost electric power.

The reason for its smooth, vibration-free operation is in its prime mover—a new Onan designed, opposed two cylinder air-cooled diesel engine. The result of long research and intensive study by Onan engineers on a two-cylinder opposed type diesel engine, this unit runs so smoothly that it requires no bolting down, no special base. Integral shock mountings make it possible to operate this unit right on the floor. The plants' dimensions emphasizes its compact design: Length —38¾ in., Width—30¼ in., Height—26⅛ in. Adaptable to portable applications, it is available in 60 or 50 cycle and in all standard voltages. It provides economical electric power for resorts, hunting lodges, construction projects, oil barges, farms, country estates and many other applications where low-cost primary electric power is essential.

Longer engine life is obtained by the extra-large bearing surfaces and forced pressure lubrication; greater economy and convenience assured by compression starting and running on diesel or domestic fuel oils. Air-cooling and an over sized (6 quart) oil sump keeps servicing requirements at a minimum. Two large oil bath cleaners and a primary and a secondary fuel filter are standard equipment. Two intake air manifolds have built-in electric heaters operating from the starting bat-



teries. In cold weather these air heaters greatly reduce cranking time and limit the heavy drain on the batteries. The 5kw generator is directly and solidly connected to the engine crankshaft, assuring permanent alignment for the life of the unit. The saturated field generator is completely self regulating without the use of any additional electrical controls and is warranted to produce its full rated capacity.

All 5DRP models are electrically cranked from a start-stop switch control located on the plant. Remote-control stations can be installed within twenty feet of the unit

40th Anniversary of Dayton Engineering Laboratories Company

CHARLES F. KETTERING, retired General Motors Research director, and the barn-loft gang that developed the relay-controlled ignition and first automotive electric self-starter was honored here July 22, the 40th anniversary of Dayton Engineering Laboratories Company.

The original company, now established as four GM manufacturing divisions under the Delco trade name, was incorporated July 22, 1909, by Mr. Kettering and co-founder Col. E. A. Deeds, both National Cash Register Company employes at that time. Col. Deeds now is National Cash Register board chairman.

They were joined by William A. Chryst, retired Delco Products chief engineer who shared their pioneering venture, and surviving shop helpers who at one time or another worked in the loft of Col. Deeds' barn on Dayton's Central Avenue. Also present were GM executives, and former Delco general managers—among them C. E. Wilson, GM president, who headed Delco in 1927-28.

Whitcomb Locomotives for the Argentine

THE Whitcomb Locomotive Company, Rochelle, Illinois, subsidiary of The Baldwin Locomotive Works, is now making delivery, at the rate of nine units per month, on an order for seventy-five 75-ton diesel-electric locomotives purchased by S.I.-A.M. di Tella of Buenos Aires for the Argentine State Railways. These locomotives, which are of the 0-6-6-0 type for meter gauge track, will be used in main line passenger and freight service on the Argentine roads.

75-ton Whitcomb locomotive being loaded at New York for Buenos Aires.

The locomotives were specially engineered and built to suit the operating requirements of the railway and, at the same time, to provide maximum speed, safety, power and economy. The 0-6-6-0 truck design reduces the axle load by distributing the weight evenly over the 6 axles.

The units are equipped with a Superior 900-horsepower diesel engine, Westinghouse electrical equipment, and Westinghouse straight and automatic air brakes. Maximum permissible speed is 57 m.p.h., maximum tractive effort without sand (25% adhesion) 35,000 lbs., maximum tractive effort with sand (30% adhesion) 42,000 lbs. Locomotives are designed to operate over a curve having a radius of not less than 250 ft. They are designed for multiple operation up to 4 units. The locomotive has an overall length of 48' 4½", overall height of 12' 7½", overall width of 10' 2".

The locomotives are shipped, fully erected on special flat cars with 250,000 capacity, to New York, then shipped by water to Buenos Aires, Argentina.

Mack Names Director of Purchases

J. G. VANNEST has been named Director of Purchases for the Mack Truck Company with overall responsibility for all purchasing for all of the company's plants, it is announced by A. N. Morton, vice president.

Mr. VanNest joined Mack in 1928 as clerk in the Purchasing Department in its Plainfield (N. J.) plant, and became successively buyer of finished materials, assistant to J. W. Rogers, Plainfield purchasing agent, and assistant to O. L. Lear, purchasing agent at Mack's Allentown (Pa.) plant. He will make his headquarters in the company's Allentown offices.

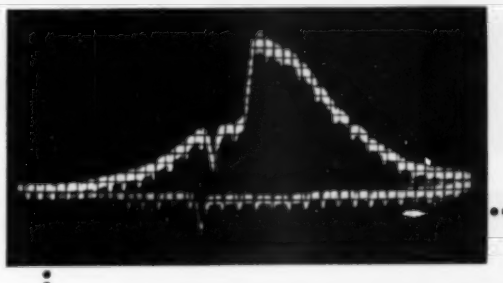


Illustration shows ideal Diesel engine performance. Ignition was about 8 degrees after top dead center. Peak pressure occurred 13 degrees after top dead center, thus angular position of crank is more favorable for efficiently converting pressure thrust into mechanical rotation. Small markers on curve are 5 degree indications, larger markers are top dead center.

PREVENT OFF-FIRING DAMAGE

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SYNCRO-MARKER PRESSUREGRAPH

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The Pressuregraph provides oscillograph pictures which show relation of pressures to engine shaft rotation (top dead center), relation of pressures to time (milliseconds) or indications in degrees of rotation. Also applicable to gas, steam or pressure line measurement of static, dynamic or instantaneous pressures. Installation requires only threaded hole in region where pressure is to be checked.

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DIESEL ENG

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Clark Brothers Co., Inc.
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National Supply Co.
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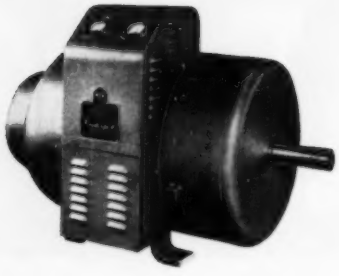

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New Booklet on Babbitt

MAGNOLIA METAL COMPANY, Elizabeth 4, N. J., has just released a leaflet describing its new D-Z-L heavy duty, genuine babbitt for sleeve bearings subject to combined weight, heat and shock. D-Z-L is recommended particularly for connecting rods and main bearings for diesel engines, large compressors and for Pitman or eccentric bearings of trap rock crushers.

The company has also published a new price list covering Magnolia die-cast Bronze bearings for replacement service on Nos. 3A, 9 and 11 Banbury Mixers.

Nordberg Appoints Vice President For Export Division

B. T. Eagerton

THE appointment of B. T. Eagerton to the position of Vice-president in charge of the Export Division of Nordberg Manufacturing Co., Milwaukee 7, Wis., is announced by R. E. Friend, president.

After several years of varied experience, including operation of his own automotive equipment distributing agency in the Southeast and as Cleveland branch manager of Standard Gas Engine Co., Eagerton joined the Cleveland Tractor Company in 1928. He was export sales manager of that company and when it was merged with the Oliver Corporation he became assistant manager of the export division of Oliver. Mr. Eagerton has been export manager of Nordberg since leaving the Oliver Corporation in 1946.

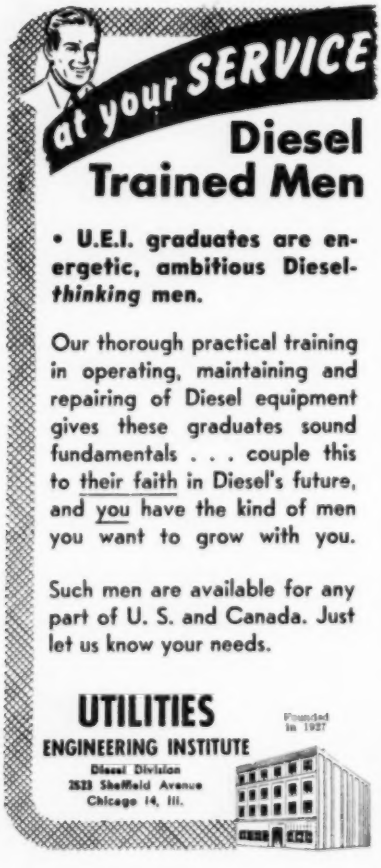
He is a native of South Carolina and studied commerce at Georgia Tech. During World War I, Eagerton served as an officer in the U. S. Navy. He is a director of the Milwaukee Export Managers Club and a member of the Milwaukee Sales Managers Association.

Nordberg's new vice-president has travelled extensively and has a wide acquaintance in export markets.

New General Motors Industrial Distributor

L. B. Smith, Incorporated, Syracuse, New York, has been appointed industrial distributor for General Motors Series 71 Diesel engines in central and northern New York state. Southern and western boundaries of the new territory assignment are formed by and include the counties of Cayuga, Cortland, Broome, Delaware, Greene and Columbia.

In addition to complete industrial sales facilities, L. B. Smith, Inc. are prepared to handle all G.M. Diesel service and parts work in a well equipped shop staffed by factory trained personnel.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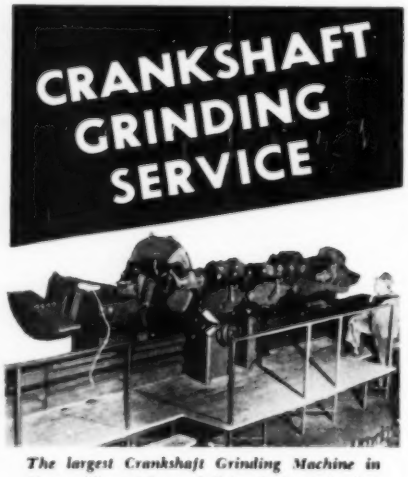

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The Western Machinery & Equipment Co., St. Louis, is saving $45 per engine cleaning series 71 GMC diesel engines in a #5 Magnus Aja-Dip Cleaning Machine. Man-hours per engine have been reduced from 31 to 16 hours. Shop production has increased 33-1/3%.

You, too, can make important savings in time and money with the Magnus Aja-Dip method of Diesel Parts Cleaning. Pays for itself in short time!

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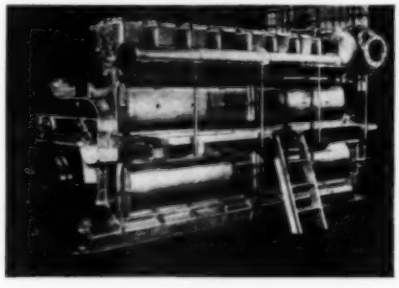

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THE ALCO plan helps Diesel plants where flexibility, economy, dependability, and provision for future growth are important. In one size of stationary Diesel engine, ALCO offers unusual advantages where multiples of 540 to 1,300 horsepower can be used.

LOW COST...This basic design, also used in ALCO switch engines, is quantity-produced to make both first cost and the cost of replacement parts unusually low.

FLEXIBILITY...You can fit fluctuating load curves more closely than with fewer engines of larger size, or of varied capacity.

LESS WEAR...This more efficient use of engines means less wear per installed horsepower. The unused capacity of operating engines at any time need not exceed the capacity of one engine. There is no wear on the idle engines. Larger engines would necessitate greater wear per installed horsepower, with resulting higher costs.

GREATER EFFICIENCY...With engines operating near rated load, fuel consumption is less and operating conditions are better.

UNIFORM ENGINE WEAR...With several units of the same size, engines can be operated in rotation, allowing planned inspection and maintenance with minimum "down time."

STAND-BY ECONOMY...When all units are the same size, stand-by capacity can be limited to one size of engine the same as all others. With a variety of engine sizes, stand-by capacity might easily have to equal the largest single unit.

SIMPLIFIED MAINTENANCE...Uniform engine size means uniformity of replacement parts and of maintenance procedures; smaller stocks of parts; minimum of special tools; shorter "down time."

EASY GROWTH...As demand increases, gradual growth can take place by adding extra units of the same size.

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What your actual savings can be with this compact, efficient engine should be computed carefully. Call in an ALCO engineer to discuss the ALCO plan in relation to your needs.

AMERICAN LOCOMOTIVE COMPANY

Department D6, 30 Church Street, New York 7, N. Y.

ALCO STANDARDIZED DIESEL ENGINES

New Director of Marketing for Burgess-Manning

Dudley W. Day

APPOINTment of Dudley W. Day as Director of Marketing of the Burgess - Manning Company has been announced by W. L. Manning, president of the company which manufactures silencers, mubbers, air-intake cleaners and acousti-booths. Mr. Day has been affiliated with the company for 17 years. Mr. Day is president of the National Noise Abatement Council which conducts a nationwide educational campaign on the subject of excessive noise and aids in the development of local noise abatement projects by city administrations, Chambers of Commerce and other groups.

New Timing Analyzer

Automotive Products' New Timing Analyzer.

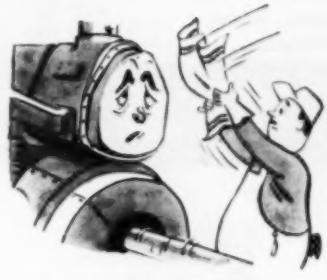
CHECKING and adjusting injector timing on Cummins Diesel Engines is both simplified and speeded up with the use of a precision made new timing analyzer placed on the market recently.

This instrument is designed for use in accurately checking, timing and setting injector push rod travel on Cummins Diesel Engines. Uniform setting of all cylinders is assured. With this instrument it is possible to check valve timing, broken or worn lower rocket shafts, as well as broken or worn lower rollers and pins.

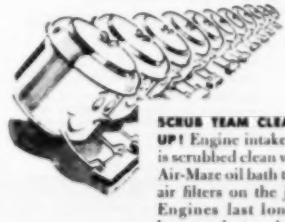
In addition, distorted lower rocker levers caused by a run-away engine, stuck valves, or excessive engine speed while descending grades may be located. In use, the Analyzer replaces the fuel injector and the engine is rotated by hand. The instrument comes packed in a special carrying case with full instructions. The manufacturer is Automotive Products, Inc., of Portland, Oregon.

As advertised in TIME and NEWSWEEK

AIR-MAZING FACTS



GIVE 'EM AIR! Diesel engines need plenty of air. They swallow 20,000 times as much air as fuel.



SCRUB TEAM CLEANS UP! Engine intake air is scrubbed clean with Air-Maze oil bath type air filters on the job. Engines last longer because dust and grit can't get in to scratch their polished insides.

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WHETHER YOU build or use engines, compressors, air conditioning and ventilating equipment, or *any device using air or liquids*—the chances are there is an Air-Maze engineered filter to serve you better. Representatives in all principal cities, or write Air-Maze Corporation, Cleveland 5, Ohio.

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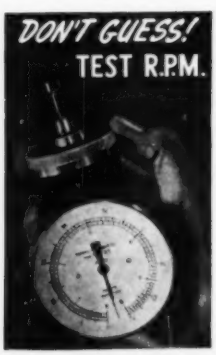

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FOR DETAILS WRITE FOR BULLETIN NO. 750.

HERMAN H. STICHT CO., INC.
27 PARK PLACE NEW YORK 7, N. Y.

WEST COAST DIESEL NEWS

By FRED M. BURT

ARMY salvage tug 185′ *Pacific Queen*, converted to freezership for Pacific Queen Fisheries, Tacoma by Puget Sound Boat Building Co., for propulsion has four 400-hp Hamilton diesels direct-connected to two 600-hp G. E. generators driving twin screws up to 350-rpm; auxiliaries three Hercules diesels driving small generators; seven refrigeration compressors driven by three G.M. 165-hp diesels plus one electric drive.

RECENTLY completed by Tacoma Boat Building Co., for Capt. E. O. Bertin, Cargueros Panamenos S.A., Mexico, 105′ steel tuna clipper *Yolande Bertin* powered with a 550-hp Washington diesel; his second clipper, 103′ wooden vessel under construction, will carry 465-hp Superior diesel; each having three G.M.671 diesels for auxiliaries.

AN Allis-Chalmers HD-19 Tractor powered with a 671 G.M. diesel for use by Hess Bros. Long Beach contractors in Federal Forestry highway construction, was specially equipped by Shaw Sales & Service Co., Los Angeles, A-C distributors, with torque converter and two extra speeds to give,—low—1.75-mph.; 2nd—3-mph.; 3rd—4.5-mph.; 4th—7-mph.

A New model 10/2 twin cylinder, 10-hp Crofton diesel for operation of ice machines, bait and bilge pumps, and generator was installed by Dick Francis, San Diego in his Kettenburg-38 *Georgie Boy*.

TO be built by National Steel & Shipbuilding Corp., San Diego, five welded steel shrimp trawlers for the Pesquera de Topolobompo, S.A. commercial fishing firm on Pacific Coast of Mexico, will each be powered by 4-cyl. 85-hp @ 450-rpm Atlas Imperial diesels.

REPLACING a gasoline engine, contractors Burch and Bebek, Inglewood are re-powering their 36″ wide ditchdigger with a "Caterpillar" D13000, 120-hp @ 900-rpm industrial diesel, also new Twin Disc reduction gear.

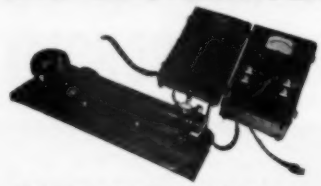
BUILT at Al Larson Boat Yard, Terminal Island for Tony Zangaro and John Sima, San Pedro, 55′ seiner *Santa Teresa* is powered with a 135-hp Atlas Imperial diesel Model 6EM253 with 2:1 Snow-Nabstedt reduction gears.

FOR the City of Whittier, Calif., a 290-hp Atlas natural gas engine for their water pumping plant, driving a Pacific pump, rated 2500-gpm @ 540-rpm, through Pacific reduction gear.

POWERED with a 60-hp Pacific diesel, with 3:1 Snow-Nabstedt reduction gears, *Miss California*, 36′ round-bottom fantail for Jas. and Nick Gangitano, San Diego was designed by Pete Rask and built at his new yard on San Diego harbor.

THE first of four seiners under construction at the Bellingham (Wash.) Shipyard, the 55′ *St. Peter* for Pete Xitco, to fish in Alaskan waters, is powered with a 135-hp Murphy diesel, with 3:1 Twin Disc reduction gear.

CRC SMOKEMETER



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Consulting Engineer, Diesel Engines; Formerly Manager of Engineering; Diesel Engine Division, American Locomotive Company.

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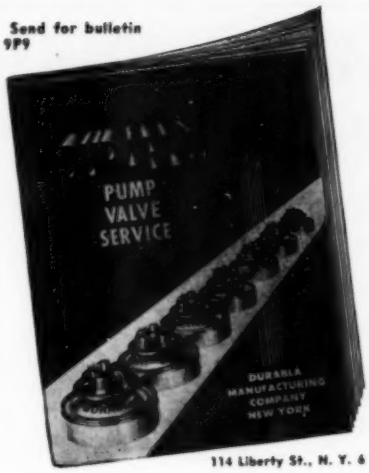

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COMPLETELY REVISED AND REWRITTEN BY ORVILLE L. ADAMS

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FUNDAMENTALS are clearly presented in a logical, step-by-step manner, with no confusing language. The author, as a Naval Officer in charge of Diesels during the War, taught classes of Army and Navy personnel. This teaching experience, added to his former work as a Diesel engineer, proved invaluable to Mr. Adams in the preparation of this great new book.

INSTRUCTORS in technical schools and colleges will find in this book an old friend—a book that stands on its own merits in a way many texts fail. The PROBLEMS, and QUESTIONS AND ANSWERS after each chapter are especially designed to help the class room teaching of this important field of engineering.

Also Available: DIESEL ENGINE TROUBLE CHART. Size 25"x38" SHOWING SECTIONAL VIEWS. It is intended for shop or school use, as a guide to maintenance and repair. $.50

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FROM Anderson-O'Brien Co., Los Angeles, a new generating set for lighting in drilling wildcat well in middle of orange grove at Anaheim, Calif., by Santa Fe Drilling Co., using G.M. 471, 103-hp diesel, driving 40-KW Electric Machinery generator. Also using three GM 671 twins, 900-hp for drilling, with four 671 G.M. diesels, 600-hp., on mud pump.

INSTALLED at National Iron Wks., San Diego, in 76′ tuna clipper *Sea Lady*, a new 240-hp Superior diesel for re-powering as propulsion engine.

NEW 53′ seine boat under construction at Jacobson boat yard, Shilsole Bay, Wash., for Hockett Thompson, Port Madison, Wash., will be powered with a 185-hp Buda diesel.

THE 122′ steel *Sea Magic*, latest of the tuna clippers from Avondale yards, New Orleans left in July to fish her way up the Pacific Coast to San Diego, under command of Manuel Fernandes, skipper, and owner with several associates; main power is a Model 567, 12-cyl. 900-hp. General Motors diesel; auxiliaries are Superiors, refrigeration by Worthington.

POWERED with a 150-hp Cummins diesel, with 3:1 Twin Disc reduction gears, designed and built by August Nordlung, Terminal Island, 45′ troller *Danbill*, will be used by D. W. and W. F. Hoferer, Long Beach for their first year of commercial fishing during 1949 Albacore season.

SUPPLIED by Thomas A. Short Co., San Francisco, a new Caterpillar D318 diesel with 3:1 Twin Disc reduction gear for more power on 38′ combination boat *Anna B.* owner Frank Bramante, to replace old "Cat" D4600.

THE new salmon purse seiner *Dreamland*, from Pacific Boatbuilding Co., Tacoma, for Paul Bartinis, Sr., Everett, Wash., has 160-hp. 4-cyl. Washington diesel for power; to fish in Alaskan waters, Paul Martinis, Jr., skipper, Tony Mardecich, engineer.

AS announced by Chas. G. Cox, Pacific Coast Manager for Nordberg Mfg. Co., the Al-Pac Engine & Equipment Co., Seattle have been appointed distributors for Nordberg gasoline marine engines in Western Washington, parts and services for Nordberg diesels; also selling Cummins marine diesels.

SUPPLIED by the Buda Engine & Equipment Co. Seattle, a 100-hp Buda diesel to power 50′ troller *Swan*, built in Olaf Hansen's Boat Shop, Wrangell, Alaska, for O. R. Haynes; diesel oil and water tanks constructed of a special alloy by the Bue Hentze Machine Wks., Petersburg.

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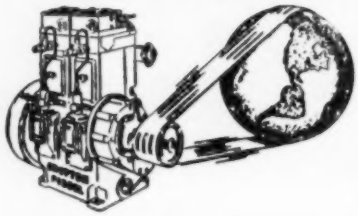

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San Diego, California

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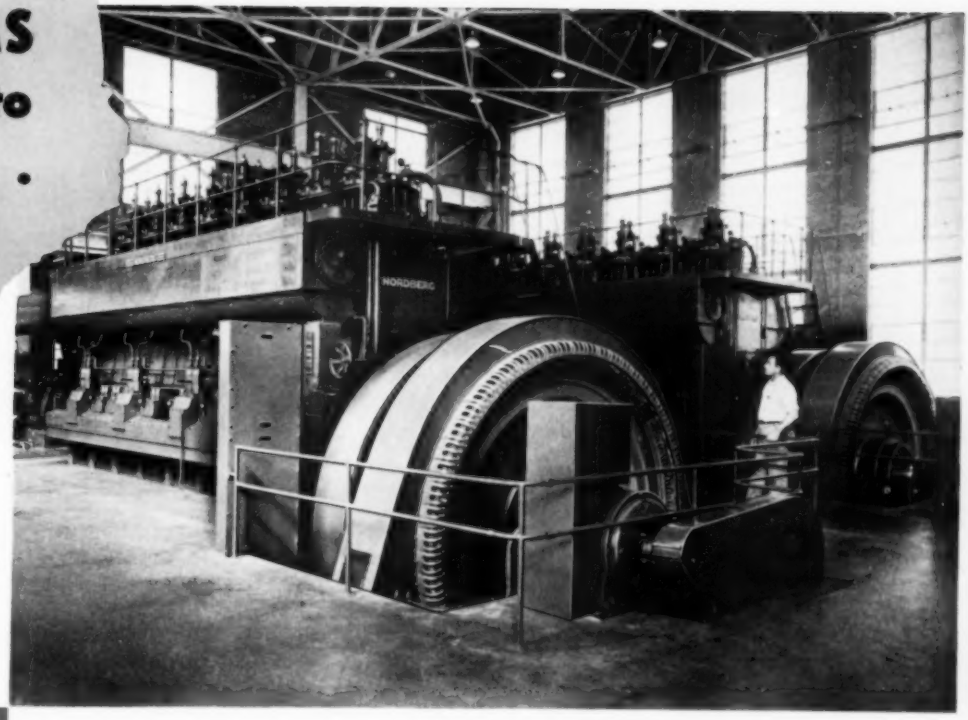
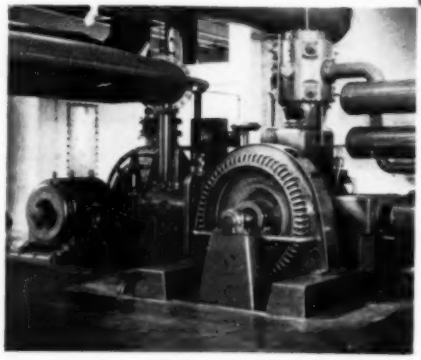
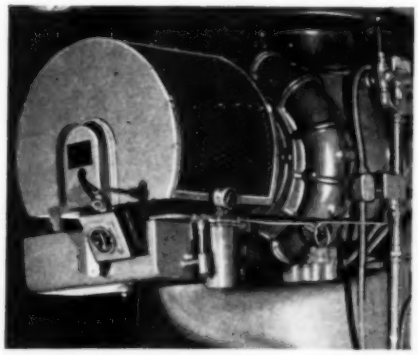


The two 3200-hp Nordberg Duafuel engines, and their Elliott Fabri-Steel generators are shown at the right.

Below: One of two Elliott 225-hp, 360-rpm synchronous motors driving gas compressors. At the left is one of the two Elliott scavenging blowers, each rated 15,000 cfm at 2.75 psig and driven by 250-hp, 3600-rpm induction motors.



An Elliott-Buchi turbocharger mounted on one of the Enterprise engines (1210 hp and 1475 hp), improving both scavenging and combustion.



Generators, blowers, motors turbochargers . . . by Elliott

This Denton, Texas station certainly is representative of forward-thinking economy, in its selection of sturdy, dependable Elliott "Fabri-Steel" generators as teammates of its two-cycle Nordberg engines as well as of its pair of four-cycle Enterprise engines.

The Elliott generators alone are indicative of discriminating selection, in their all-welded steel stiffness and strength, and their many details of superior construction which in numbers of Diesel installations are proving sound aids to lower kw costs.

Other vital aids to economy in this plant are Elliott-Buchi turbochargers which step up the power of the two four-cycle Enterprise engines, and the Elliott scavenging blowers which serve the new two-cycle Nordbergs. Elliott Fabri-Steel motors drive these blowers, and the three-stage, high-pressure gas compressors.

All in all, this Denton plant is one in which dependably low kw costs may be confidently expected.

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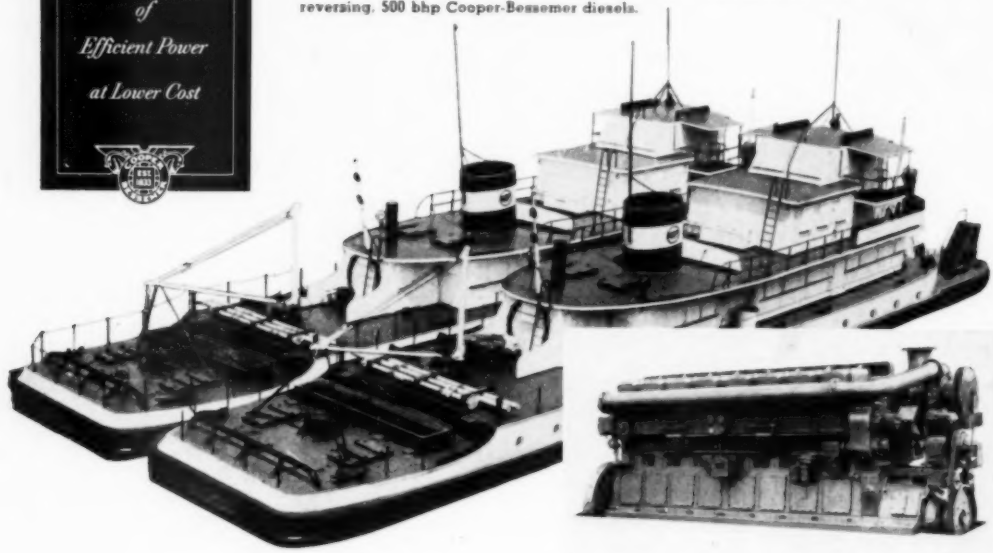

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